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BROOKLYN BOTANIC GARDEN RECORD
PLANTS & GARDENS

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BREEDING PLANTS FOR HOME & GARDEN

A HANDBOOK

How to Hybridize Begonias, African-violets and other Gesneriads, Day-lilies, Daffodils, Roses, Azaleas & Many Other Plants

A Guide for Plant Breeders

Genetics

l. 30 No. 1
(Spring 1974)

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BROOKLYN BOTANIC GARDEN RECORD
PLANTS & GARDENS

BREEDING PLANTS FOR HOME & GARDEN

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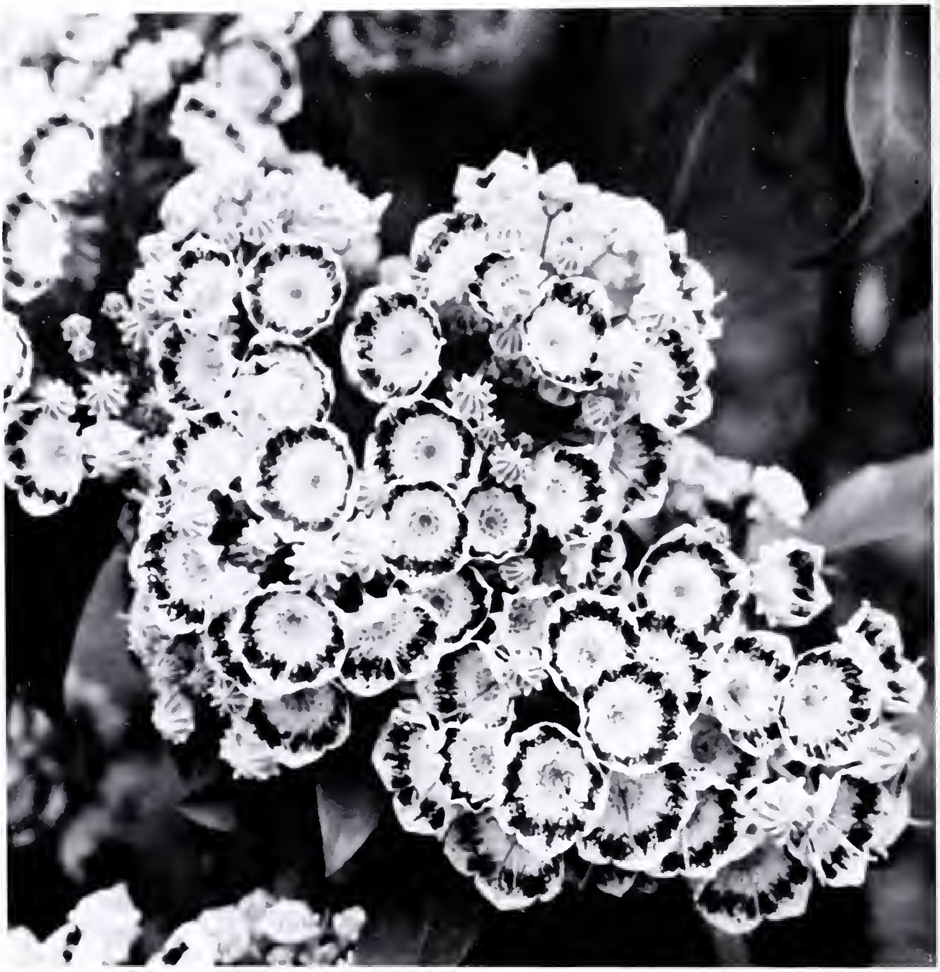


Richard Jaynes, Connecticut Agricultural Experiment Station

BANDED MOUNTAIN-LAUREL, known botanically as *Kalmia latifolia* f. *fuscata.* This attractive form is one of the unusual variants that may occur in the wild or in gardens. The trait is controlled by a dominant gene. *Kalmia* is a North American genus of seven species that were untouched by breeders until 1961, although mountain-laurel itself *(K. latifolia)* has been in cultivation since Colonial times. Promising new *Kalmia* selections will soon be available as a result of genetic studies carried out at the Connecticut Agricultural Experiment Station in New Haven. *Kalmia* is one of many genera in which opportunities abound for amateur plant breeders who want to do a little engineering in cooperation with Mother Nature. For color photographs and information on propagation of mountain-laurel selections, see Brooklyn Botanic Garden Handbook No. 66, *Rhododendrons and Their Relatives* (Summer, 1971 PLANTS & GARDENS).

LETTER FROM THE BROOKLYN BOTANIC GARDEN

As new tillers of the soil get to know the idiosyncracies of the plants in their garden and eventually become experienced gardeners, they may notice that some trait of their particular garden favorite leaves something to be desired. Perhaps a plant may grow too tall and leggy, or the flower color—or size—isn't quite right. Sometimes a plant may be undependable in rugged winters. The average gardener doesn't usually pursue the matter further, except perhaps to seek out a similar but slightly more attractive or amenable kind from a nursery or florist. Occasionally, that plant does not exist and, occasionally, the experienced gardener will insist on tailoring his own, through hybridization.

The purpose of this Handbook is to open a brand new world to gardeners who have always wanted to know about plant breeding but were afraid to ask. Actually, the basic techniques of hybridization are rather simple and, contrary to popular impression, can in most cases be mastered in a few hours. However, be sure to read Dr. Clayberg's and Dr. Emsweller's introductory articles before turning to the others so you won't stumble over some of the technical terms. Read further and let this special-feature issue of PLANTS & GARDENS be a cordial invitation and a guide to experiment with your favorite species or cultivar that needs refinement.

Guest editors Carl Clayberg and Richard Jaynes, both of whom are professional geneticists, have worked diligently in their leisure time for more than a year to see that this Handbook came to life. It is their strong feeling, as well as that of the editorial committee, that there should be an up-to-date broad-spectrum introduction to ornamental plant breeding on the home gardener's bookshelf. To our knowledge, there is nothing else in print with the same scope as the Handbook they have nurtured. At this time let us extend a very warm word in appreciation to Drs. Clayberg and Jaynes and to the all-star list of contributing authors they have enrolled in this national horticultural effort.

Dick Jaynes has suggested that we mention the importance of contributions to plant breeding by the amateur gardener. Such contributions are legion. It may come as a surprise to some readers, but relatively little governmental or institutional effort has been given to the hybridization of plants for ornamental horticulture, although the gardening industry is one of the fastest growing and most promising spokes of the "agricultural" umbrella today. In fact, many of the professionally trained breeders and geneticists are doing some or all of their ornamental breeding on their own time. There is plenty of room for the backyard hybridizer. Why not dust a bit of pollen if you are so inclined? It will widen your perception of the living green world and perhaps even provide a fascinating long-term hobby.

May the seeds of our contributors' thoughts germinate in your garden.

Frederick McGourty, Jr

Editor

Can a sculptor become a rhododendron hybridizer or a photographer a delphinium breeder? The answer of course is "yes"—two examples being Edmond Amateis, hybridizer of rhododendrons, and Edward Steichen who made delphinium breeding his serious hobby.

A HOBBY FOR ALL AGES

George L. Slate

Breeding ornamental plants can be an engrossing and rewarding hobby. It is often a natural follow-up to an initial interest in a certain flower, for one does not suddenly on retirement decide to breed roses, gladiolus, iris, or some other popular flower. First a few crosses are made and then the interest increases and one is soon a full-fledged breeder.

If one is planning to breed ornamental plants, it is much more satisfying to do a good job than just to dabble. Just what is a good job? The amateur plant breeder should attempt to produce better cultivars of his chosen flower than are currently available—or at least strive for results that will please him even if they have no commercial value. He should also make himself an authority on his chosen plant.

What are the qualifications of a successful flower breeder? First, he must love plants and know how to grow them well. Plantsmen are usually born, not made, but if the urge to grow and improve plants is there, the other qualifications will develop. Patience is essential because some plants require several years from cross to flowering. One must be curious, enthusiastic, eager to learn, and not be discouraged by disappointments.

A small library of books about one's chosen flower is desirable. The most important books are the publications of the special plant societies. One must learn to evaluate the literature and separate the cockeyed ideas from the good ones. Experience in growing one's chosen flower increases the ability to evaluate the literature. An elementary knowledge of botany and heredity is desirable, although many amateur plant breeders know very little about such things.

Of prime importance is the ability to judge plant material. This is especially important if one intends to introduce new cultivars. One must be able to look ahead and make selections with characteristics to be used in the breeding program. Seedlings of no value in themselves often have characteristics that can be used in a well-planned extensive project.

A good knowledge of existing cultivars is highly helpful. There are several ways of acquiring this knowledge. One can buy the standard ones available from growers and dealers. This is expensive if one attempts to acquire all the new cultivars which are introduced each year. Very few of these are worth the inflated prices at which they are offered and soon they will disappear because they are not superior to the ones already being grown. Moreover, restraint in the acquisition of new plants must be used because with some species indiscriminate collection is a sure way of getting a collection of virus diseases.

Trial gardens and the shows of specialist societies are sources of information about cultivars. Some nurseries have display gardens and some individuals maintain extensive collections as a basis for their breeding work. Some organizations conduct symposia and publish the results which are very useful to one who does not know which cultivars to buy.

One must also know something about the diseases and insects which trouble the plants one is working with. Soil sterilization can be useful in controlling soil-borne diseases and eliminating weeds from a seedbed. Herbicides, if used according to directions, can greatly reduce the time spent in weeding.

What are some worthwhile objectives for the amateur plant breeder? The first and most important objective is to get as much pleasure as possible. Unless it is fun, one will soon tire of the project. The overall objective is to originate better plants than those being grown and, if one is so inclined, to get them into the gardens of others.

An important objective is the gradual adapting of a species to the conditions in the area where it is being grown. In the northern states, winter hardiness is very important for plants which spend the winter in the garden. In the South, heat tolerance becomes important as well as resistance to diseases which are serious in a hot humid climate. Growth habit and ease of propagation are important. A beautiful plant that is difficult to propagate may be useful in one's own garden, but is not likely to go far commercially. (However, commercial production is not always of concern to or an aim of the amateur breeder.) Flower characteristics to be sought are purity of color, new colors perhaps, substance and keeping quality, tolerance of bright sun and heat without fading, placement of flowers, and desirable form. Much can be learned about desirable flower characteristics by visiting the shows of specialist societies and seeing which flowers win the prizes. Judges at the shows are a good source of information (but not when judging!).

The breeder at the beginning will have to decide what plant to hybridize—an old favorite, or an obscure plant that needs improvement. I chose the lily because there are over 80 species with a wide range of color and form, and several methods of propagation exist. The disease problems I considered a challenge. Dr. A. B. Stout chose the day-lily, which had received very little attention previously. There were only a few species and not the wide variation that there is among other plants. His hybridizing laid the foundation for the great improvement and wide popularity of the day-lily that has occurred in the last 50 years.

Iris, dahlias, peonies, gladiolus, chrysanthemums, daffodils, tulips, roses and rhododendrons have all been hybridized extensively for many years. The improvements are slight and many of the new cultivars introduced each year soon disappear because they are no better, or not equal to those already available. He who works with these plants will have to raise large numbers of seedlings from many crosses for a number of years before he can hope to produce anything better than what is already known. There is much competition with these flowers.

One possibility with these popular flowers is to look for a species that may have been overlooked by the other breeders and incorporate it in a program. The commercial rose breeders are working mostly with the hybrid teas and floribundas. Yet there are from 100 to 200 species and some of these might well be used by the amateur breeder. Winter hardiness and disease resistance are very worthwhile objectives with roses.

Turning the pages of Bailey's *Encyclopedia of Horticulture* is a systematic way of searching for a genus that looks interesting and in need of improvement. The article in the *1937 Yearbook of the United States Department of Agriculture* entitled "Improvement of Flowers by Breeding" is an excellent survey of what has been done to improve many garden flowers. The publications of the flower societies have much information of value to the amateur breeder. (See list below.)

Breeders who make many crosses and raise large numbers of seedlings soon discover that only a few cultivars are good parents. An English daffodil breeder expressed this when he wrote "It really is extraordinary what shocking seedlings sometimes come from the most exalted and expensive parents." Many crosses are made, but very few pay off with good cultivars. The breeders of ornamentals who are producing good new cultivars are those who know which ones are good parents. It takes many years and many disappointments to determine the good parents; when they are known they should be used extensively. Then the breeder will begin to reap the rewards of his efforts.

The rewards are several. There is always something new coming along. One can hardly wait for the flowers to open in a batch of new seedlings from an interesting cross. There is always hope that the perfect variety will appear among the seedlings. An English iris breeder once said, "A person with unbloomed iris seedlings will not commit suicide." When a fine seedling flowers that appears to have much merit, it gives the breeder a great pleasure to admire his handiwork and plan its future as a possible new cultivar and as a parent.

Another reward is the friends one makes with others who are working with the same plants. Those with a deep interest in a flower join the special plant societies and make good friends among those with similar interests. And finally it is pleasant and relaxing to work among plants in the open air.

PLANT SOCIETIES

The following list of national organizations includes only those whose plants are considered in this Handbook. Addresses for additional societies may be found in the *Directory of American Horticulture*, obtainable from the American Horticultural Society, Mount Vernon, Virginia 22121.

African Violet Society of America, Box 1326, Knoxville, Tennessee 37901

American Begonia Society, 10331 S. Colima Rd., Whittier, California 90604

American Camellia Society, Box 212, Fort Valley, Georgia 31030

American Daffodil Society, 89 Chichester Road, New Canaan, Connecticut 06840

American Gloxinia and Gesneriad Society, Box 174, New Milford, Connecticut 06776

American Hemerocallis Society, Mrs. Arthur W. Parry, Secretary, Signal Mountain, Tennessee 37377

American Iris Society, 2315 Tower Grove Avenue, St. Louis, Missouri 63110

American Magnolia Society, 2150 Woodward Avenue, Bloomfield Hills, Michigan 48013

American Orchid Society, Botanical Museum of Harvard University, Cambridge, Massachusetts 02138

American Rhododendron Society, Mrs. Bernice Lamb, Executive Secretary, 2232 N.E. 78th Ave., Portland, Oregon 97213

American Rock Garden Society, Milton S. Mulloy, Secretary, 90 Pierpont Rd., Waterbury, Connecticut 06705

American Rose Society, P.O. Box 30,000, Shreveport, Louisiana 71130

Cactus and Succulent Society of America, 1593 Las Canaos Rd., Santa Barbara, California 93105.

Holly Society of America, Bluett Green, Jr., 407 Fountain Green Rd., Bel Air, Maryland 21014

International Lilac Society, Walter W. Oakes, Secretary, Box 315, Rumford, Maine 04270

North American Gladiolus Council, Bob Dorsam, Membership Secretary, 30 Highland Pl., Peru, Indiana 46970

North American Lily Society, Betty Clifford, Executive Secretary, Rte. 1, Box 395, Colby, Wisconsin 54421

Northern Nut Growers Association, Spencer Chase, Secretary, 4518 Holston Hills Road, Knoxville, Tennessee 37914

Saintpaulia International, Box 549, Knoxville, Tennessee 37901

Terms and explanations plant breeders should come to know

FUNDAMENTALS IN PLANT BREEDING

Samuel L. Emsweller

The first plant breeders probably were prehistoric men who, observing that some plants used for food were better than others, saved seed from the best for the next year's crop. We have no records that conscious selective breeding was practiced by early man, but the fact that certain types of corn and other grains are known to have gradually undergone improvement in prehistoric civilizations indicates that some form of selection was done.

Scientific plant breeding was explained by Gregor Mendel of Austria who published the results of his breeding work with garden peas in 1866. Although his report presented a lucid explanation of how plant characters were inherited and was well supported by ample evidence, the botanists of that period failed to understand his outstanding and fundamental discovery. His publication gathered dust on the shelves of the little Brunn Natural History Society in Austria for 34 years while speculation continued as to how plant characters were transmitted from one generation to the next.

In 1900, sixteen years too late for Mendel to receive the acclaim due his discovery, three scientists, H. de Vries (Holland), C. Correns (Germany), E. von Tschermak (Austria), simultaneously discovered Mendel's paper and verified his results. From 1900 plant breeding became scientific: something over which man could exercise some form of control and predict results when certain plants were cross-bred.

The variations that occur in closely related plants may be caused by heredity or by response to the environmental conditions under which the plants are growing. Heredity determines that petunia seed will always produce petunias, but those of a particular kind may be very good or very poor, their quality depending in part on the gardener who grows them. Variations caused by environment are referred to as modifications and are not inherited.

Principles of Propagation

To carry on effective plant breeding, the breeder must understand several basic principles. Plants can be propagated by asexual or sexual methods. If a plant is increased by division or by cuttings, the method is called *asexual* and the resulting progeny is called a *clone*. No matter how many cuttings are made from the plants of a clone, they will all be identical. Many of the finest cultivated flowering plants and shrubs are clones, and even though millions of plants of a clonal cultivar exist, they are identical because they all trace back to one plant. Examples of such cultivars are the "varieties" of iris, tulip, narcissus, spirea, lilac, and many others.

Much time and effort are often wasted by amateur breeders who believe they can improve a clonal cultivar by selecting for propagation what they believe to be the better plants. Considerable effort, for instance, has been expended by some growers of Easter lily bulbs who have selected the more desirable single-nose bulbs for propagation, believing they would thus eliminate double- and triple-nose bulbs. If some plants of a clonal cultivar are affected by a virus or any other disease, selection of the healthy individuals for propagation is, of course, advisable. This will result in restoring the stock to its original healthy condition, but will not change its heredity. Such selection is *not* plant breeding.

The second method of propagating plants is by use of seeds. This is referred to as *sexual propagation*. A seed originates as the result of the union of two sex cells: a nucleus in a pollen grain from the anther with a nucleus in an egg cell produced by an ovule formed in the ovary of the flower. If the pollen and egg cells are borne on the same plant or on two plants of the same clone, the seed is said to originate from *self-pollination;* if they are from two plants differing from one another in several or many characters, the term is *cross-pollination*. The sex cells are called *gametes*, those produced by pollen being the male gametes, and the eggs the female gametes. Each contributes equally to the formation of the embryo that will develop in the seed and eventually give rise to a plant. Following the union of the two gametes after pollination, a single-celled embryo is formed which grows into the mature embryo that occurs in every seed.

The gametes are single cells; and although very small, they carry within them the power to determine all the characters that will be possessed by the plant produced by their union. If a pollen grain is stained with a dye and placed under a microscope, a round dark-stained body called the *nucleus* is visible within it. If a section is cut through a stem, a leaf, or a root, a large number of cells, each containing a nucleus imbedded in a jelly-like substance called *cytoplasm* may be seen.

Role of the Nucleus

The nucleus is the vehicle in the cell that carries the units which determine the heredity of a plant. The units are called *genes* and they are arranged very much like a string of beads on a body called a *chromosome*. In a few instances the cytoplasm also functions in heredity. Such cases are very rare, however, and the plant breeder may never be concerned about them. Each living cell in a plant contains a *nucleus* and all nuclei, except those in pollen and egg cells, contain the same number of chromosomes. For example, the chromosome number in all cells (except the gametes) of all ordinary Easter lilies is 24; that in all 'King Alfred' daffodils is 28. The chromosome number of pollen and egg cells is always half that of all other cells in the plant. If this were not true, each time a pollen grain and egg cell united in fertilization, the chromosome number of the embryo produced would be doubled.

The cells that compose the body of the plant are called *somatic cells* to distinguish them from the sex cells, *gametes*. Somatic cells form the roots, stems, leaves and most parts of the flowers of a plant. The sex cells (pollen grains and eggs) are found only in the anthers and ovaries. When the cells of a plant with large chromosomes, such as lilies, are observed under a microscope, the chromosomes are seen to differ from one another in structure. Careful examination of the chromosomes of an Easter lily reveals 12 different kinds of chromosomes. There are 2 of each kind, one contributed by the pollen grain and the other by the egg cell at fertilization. Two similar chromosomes in a pair are called *homologues*.

How a Plant Grows

All plants start as single-celled embryos. The embryo increases in size by successive cell divisions, each daughter cell receiving the same number of chromosomes. This is accomplished at cell division by each chromosome splitting lengthwise as if it were equipped with a zipper and by its two daughter halves separating and moving to opposite sides of the cell. A new cell wall is then formed between the two groups of chromosomes. This type of cell division is called *somatic mitosis*. Each new daughter cell will contain the full number of chromosomes. Such divisions are repeated many hundreds of thousands of times as the embryo develops in the seed and finally produces a full-grown plant.

After the chromosomes split during cell division, the cell will contain twice the normal number of chromosomes if it fails to divide. Such an Easter lily cell will contain 48 chromosomes composed of 4 each of the 12 types. This condition is called *polyploidy;* and since each chromosome occurs in quadruplicate, the cell is called a *tetraploid.* If such a cell eventually forms a branch or a bulb, that part of the plant and the flowers formed by it will be tetraploid.

The sex cells do not appear until the flowers form. As the young flower develops, one group of cells forms anthers and others an ovary. At a certain stage of development of an anther, there are formed some cells in which the chromosomes do not split as they do in the type of division described for somatic mitosis. Instead, each chromosome closely associates with its mate, and when the cell divides the intimately paired chromosomes separate as whole bodies. The two new cells formed receive only one of each type of chromosome present and thus are *haploid,* having half the number of chromosomes found in all other cells of the plant. This type of cell division is called *meiosis* and from it arise the sex cells.

Role of the Chromosome

As mentioned earlier, the chromosomes are the carriers of the genes that control the inheritance of the plant. The genes are arranged on the chromosome like a string of beads, and all the genes on any one chromosome will be inherited as a unit group unless something occurs to break and rearrange the gene string. The tendency to be inherited as a group is called *linkage,* and the genes in a chromosome are referred to as a *linkage group.*

Fortunately, linkage is broken by the exchange of pieces between two chromosomes as they pair during meiosis. This exchange of genes is called *crossing-over.* As a result of crossing-over, new combinations of genes are formed, and the greater the frequency of such gene interchange, the greater the variability to be expected in the seedlings obtained from a hybrid formed by crossing two plants differing in many characters. Since, because of linkage, genes are transmitted in groups, plant breeders are more concerned with whole groups of genes than with a few. Linkage often makes it difficult to transmit desirable genes without carrying along undesirable, closely linked ones because they are located in the chromosome close to the desirable genes.

How Plant Characters are Inherited

A gene is located at a specific place on a chromosome; this point is called a *gene locus.* A plant character, such as flower color (white, red, or perhaps pink), may be controlled by a series of genes. A group of genes, each one capable of affecting the same character in a different way, is called an *allelomorphic series.* The two chromosomes of a pair may each have the same gene of an allelomorphic series at a given locus and if so the plant is called *homozygous* for this particular character. When, however, one chromosome of a pair carries a gene that determines that the color of the flower will be red, and the partner chromosome carries the allelomorph gene for white, the plant is called *heterozygous* for color. Such a plant is said to be a hybrid for color although it may be homozygous for many other genes. The flower color may be red or white, depending on which gene is dominant. If the flower is red, the gene for red is said to be *dominant* over the white gene, which is called *recessive.* Sometimes neither gene is fully dominant and the color of the flower may be intermediate. This condition is referred to as *incomplete dominance.*

If a plant is heterozygous at a given locus, only the dominant allelomorph will be able to express itself in the hybrid. The recessive gene, though present, is unable to function. In homozygous plants, the gene present can express itself either as a dominant or homozygous recessive. When self-pollinated, a homozygous plant will breed true for the color gene it happens to have. If, however, the plant has one red dominant gene and its allelomorph is a recessive white gene, the plant will have red flowers and will not breed true when self-pollinated. In the next generation, three-quarters of the plants will exhibit the dominant character and one-quarter the recessive character.

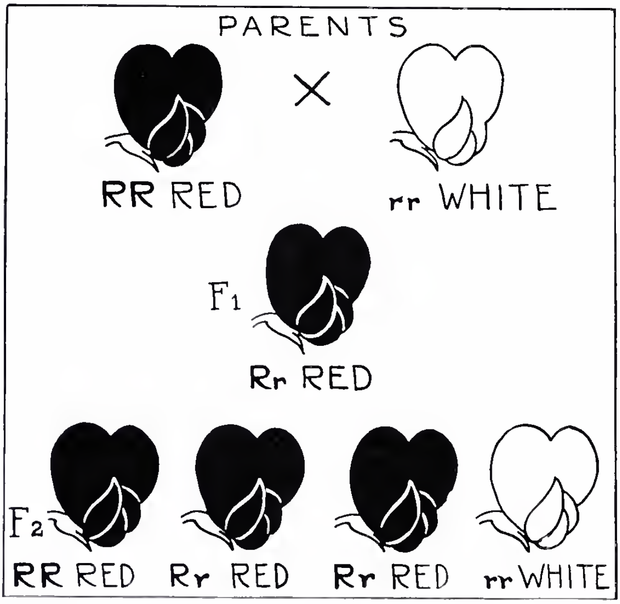
When a recessive character appears in a plant it indicates that both genes controlling the character are recessive, and the plant is homozygous for that character. A description of the observable characters of a plant is called the *phenotype* of the plant. It is impossible to know all the genes in a plant, and the inheritance of but a few are studied at one time. When the genes present for a character or a group of characters are known, they are referred to as the *genotype* of the plant for these particular characters.

Since there are dominant and recessive genes, a hybrid should always be bred into successive generations so that plants with the recessive characters may be obtained as well as those with the new recombinations of genes resulting from the crossing-over that occurred in the hybrid.

When two plants are crossed to obtain a new plant combining the best qualities of each parent, the hybrid is called the F_1. If the F_1 plants are self-pollinated or intercrossed, the next generation is called the F_2 generation, and succeeding generations obtained in the same manner are called F_3, F_4, etc.

The Backcross Method

A plant may possess relatively few good characters and many poor ones. When it is crossed with another plant that has many good characters, plant breeders may utilize the backcross method of breeding. This consists in crossing the F_1 hybrid with either parent. It enables the breeder, by repeatedly crossing back to the better parent, to accumulate the desirable genes more rapidly. If the desirable genes of



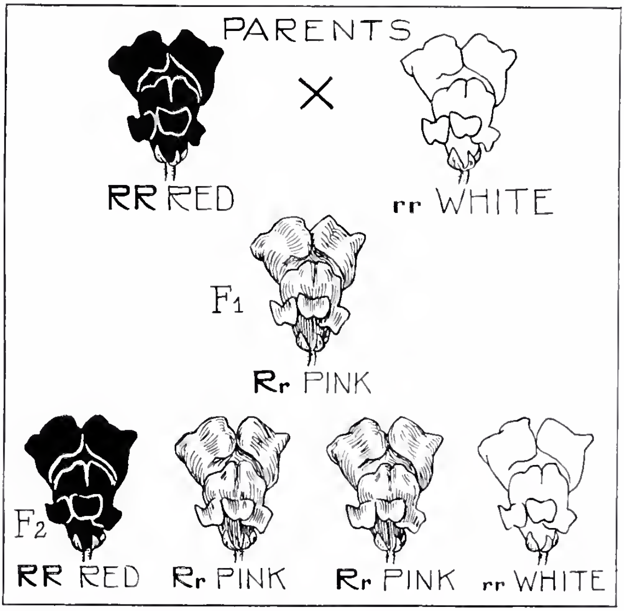
Complete dominance of flower color. In this instance, when a red sweet pea (RR) is crossed with a white one (rr) the plants grown from the resulting seed produced red flowers (Rr) in the first generation (F_1). When these red-flowered offspring were self-pollinated, three-fourths of the second-generation plants (F_2) produced red flowers and one-fourth white, demonstrating the dominance of red color over white.

the poor parent are recessive they will not appear in the hybrid. It then becomes necessary to utilize self-pollinations as well as backcrosses in each generation to discover what plants possess the desired genes. In each generation the breeder can select, for backcrossing to the better parent, those plants showing the presence of the best genes of both parents.

Mutations

The sudden appearance of a new character in a growing plant is called a *sport*, or a *mutation*. These fortuitous changes may occur in branches, in flowers, or in any other part of a plant. They may be due to a change in a gene or in its location in the chromosome or to a structural rearrangement of the genes in a chromosome. Sometimes a mutation occurs in plant tissues that do not give rise to sex cells. Such mutations are not heritable and are called *chimeras*. When it is possible to propagate a mutation asexually it may be considered a *new cultivar* or *strain*. These sudden changes are responsible for the origin of many cultivars of roses, carnations, and other plants. The rose cultivar 'Ophelia' has produced many mutants, and certain chrysanthemums mutate with such a high frequency that they have been discarded by florists.

The plant breeder has no control over the frequency or type of mutations that appear and merely being the owner of a plant that does produce a valuable mutation is similar to winning a sweepstake. The appearance of mutants must be accepted as an accidental event, not as the result of plant breeding. ❧



Incomplete dominance of flower color. Mendel's theory of heredity of such factors as flower color, is demonstrated above. In snapdragons, a red-flowered parent is crossed with a white. Red (indicated as RR), not being completely dominant over white (rr), gave plants that produced all pink flowers (Rr) in the first generation (F_1). However, when the pink-flowered offspring were self-pollinated, flowers on the second-generation plants (F_2) were one-fourth red, one-half pink, and one-fourth white. These are "Mendelian" ratios, and this illustrates one of Mendel's laws of inheritance.

Step-by-step hybridizing

A GUIDE FOR THE PLANT BREEDER

Carl D. Clayberg

AS A BEGINNING PLANT BREEDER your interests will determine the group or groups of plants to work with. But you must have suitable growing facilities and climate for the group you pick. The ornamentals best adapted to a particular climate are *those that are bred in that climate.* Cultivars (cultivated varieties) of wide adaptability are relatively rare. The cultivars or species best adapted to your climate are also likely to be among the most satisfactory parents you can use in your breeding.

You must decide whether to work with perennials or annuals. Perennials are generally simpler to breed because once a good plant is developed it usually can be propagated vegetatively. To perpetuate an outstanding annual normally requires careful selection and line breeding for several generations after the desired type is first identified.

Once you have chosen your plant group, learn all you can about it. (The national plant society concerned with the plant group is one of the best sources of information. See page 6 for a list of plant societies.)

Making the Cross

Now you are ready to start hybridizing. To cross pollinate two plants you must take the dust-like pollen from the anthers of flowers of the pollen parent and apply the pollen to stigmas of flowers of the seed parent. The pollen is ready to transfer when the anther opens up (dehisces). When the stigma is ready to be pollinated (receptive), it is usually fully expanded and often becomes sticky. A stigma that has started to discolor or turn brown is no longer receptive, and application of pollen will not likely result in seed set.

If the anthers are large enough, simply rub them lightly over the stigma to transfer the pollen. Otherwise, a small brush or the blunt end of a flat wooden toothpick will do. Be gentle so as not to damage the surface of the stigma. I prefer a dissecting needle with a flattened and rounded tip. You can make one by inserting a finishing nail or a short length of steel wire into a wooden dowel for a handle. Heat the wire or nail in a gas flame, hammer it flat, round the tip with a file, and then temper by reheating and plunging into cold water. Sterilize your equipment between different pollen lots by dipping the needle or brush into ca. 70% ethyl or denatured alcohol and then wiping dry on a clean tissue; discard the toothpick.

If two parents of a desired cross differ markedly in length of style, the long-styled one should be used as pollen parent because pollen from short-styled plants is often not adapted to growing down long styles.

Flowers are naturally pollinated by wind, birds, bats, or a variety of insects such as bees, moths and flies; and some flowers naturally pollinate themselves. To prevent self-pollination it is best to emasculate flowers of your seed parent before pollinating them. Emasculation is the removal of anthers from the flower before they shed their pollen. On large open flowers, like lilies or irises, this is easily done by breaking them off with a forceps. Sterilize the forceps between handling flowers of different plants. Only emasculate flowers that are just about to open; they will not have been visited by insects or other pollinators.

In many plants the pollen is shed from the anthers a day or two before the stigma is receptive. Thus, the stigma may not be receptive when you emasculate a flower of the seed parent. In the mean-time, to protect the stigma from pollination by natural pollinators, you can do one of several things. If the petals of the flower are large enough, as in some species of *Nicotiana*, you might bring them together and fasten with a wire-cored twist-tie, such as is used to tie plants to stakes. Or you might protect the stigma with a cap of aluminum foil, a length of soda straw with the tip bent over, or half of a gelatin capsule (obtainable from your druggist). One of the best and easiest procedures is to remove most of the petals, and sepals if they are showy as in iris, which will keep insect visitors away because they will not recognize the flower nor have a landing platform to alight on. You should be careful not to damage the pistil (= stigma + style + ovary), as this could prevent fruit or seed set upon pollination. This caution equally applies to emasculation. Emasculated flowers can be protected by enclosing them in a bag made from a nylon stocking or by covering the entire plant in a cage of fine netting. A less complicated method is to pollinate the stigma heavily when you emasculate the flower, or pollinate heavily just after the flower opens without emasculation. Even if insects bring in other pollen later, you will have been there first with the most. Although the stigma is not likely to be receptive when you apply the pollen, the pollen usually will remain alive until fertilization is accomplished.

Flowers in the composite family, chrysanthemum for example, are really compound structures consisting of many flowers or florets. The florets are of two types: ray and disk florets. The peripheral ray florets with strap-shaped corollas, that we incorrectly think of as the petals of the floral head, possess a pistil but lack stamens. The disk florets at the center of the floral head have much reduced corollas but possess both pistil and stamens. Some composites, like the marigold, are self-incompatible (described later), but others, including chrysanthemum, are self-compatible and must be emasculated if exclusion of self pollen from a cross is critical. This is done by removing all of the disk florets with a scissors, forceps or razor blade before they mature and shed their pollen. On double flowers which have few disk florets, some of the central ray florets may have to be removed in order to reach the disk florets.

The best pollen to use in pollination is from freshly collected anthers. These should be taken from flowers that are nearly ready to open, so they will not be contaminated with foreign pollen brought in by insects. Pollen in anthers at this stage often is still so moist that it does not shed readily from the anther and is not easy to transfer to the stigma. If this is so, let the anthers dry out in an open container for several hours before using them.

Storing Pollen

When the pollen and seed parents bloom at different times, it is necessary to store pollen until the cross can be made. Storing pollen is one of the plant breeder's most valuable techniques and, while it is simple to do, success depends upon the plant group involved. There are two types of pollen: binucleate, that is, each pollen grain contains two nuclei; and trinucleate. James L. Brewbaker reports that genera, and even entire families, have either binucleate or trinucleate pollen. The importance of this to the plant breeder, according to Brewbaker, is that the two types of pollen differ physiologically. Binucleate pollen stores well at low humidity and low temperatures, especially below freezing. At extremely low temperatures it might live indefinitely. In contrast, trinucleate pollen is short-lived under all conditions but keeps best at high relative humidity and temperatures just above freezing. Most plant families containing ornamentals have binucleate pollen. Those for which only trinucleate pollen has been reported are: Cactaceae, Cannaceae, Caryophyllaceae, Compositae and Geraniaceae. Both kinds have been found in the Campanulaceae and Labiatae.

While freezing will probably prolong the life of all binucleate pollen, it is not always necessary. Most rose pollen, for instance, can be kept for as long as a year by storage at 34–40° F. The best way to store binucleate pollen, frozen or unfrozen, is to collect it in a small open vial and nest this in a slightly larger closed vial containing a little dry desiccant like silica gel to keep the pollen dry. Put this set of vials into a larger tightly closed container, like a pint mason jar, also with dry silica gel and keep the jar in a refrigerator, preferably in the freezing compartment. The reason for the double protection is to keep moisture from condensing on the pollen in the open vials every time you open the jar. Before freezing fresh pollen, keep it in a sealed jar with silica gel at room temperature for several hours to reduce its moisture content so that it does not burst when frozen. The "Tell Tale" type of silica gel, available from chemical supply firms, is particularly useful; it is dark blue when dry and pink when saturated with moisture, at which point it can be dried out again by putting it in a 300° F oven for several hours.

Self-incompatibility

For many species, individual plants are not capable of setting seed with their own pollen; this phenomenon is called self-incompatibility. However, such plants are usually cross-fertile with other plants of the same species. To obtain an F_2 from an F_1 between two cultivars of a self-incompatible species, you must inter-cross different F_1 selections (sib cross). Self-incompatibility has been reported in most plant families containing ornamentals, although these families often contain self-compatible genera or species also. Families in which no self-incompatibility is known include the Cactaceae, Caryophyllaceae, Gesneriaceae, and Aquifoliaceae where, however, plants may be male or female and thus just as self-sterile as a self-incompatible plant. Sometimes a self-incompatible plant can be self-pollinated by opening the bud and applying pollen to the stigma 1-3 days before it is normally receptive (bud pollination).

Use of Colchicine

Another technique available to the breeder is the ability to double the chromosome number of a particular plant with the alkaloid colchicine. It is prepared from the autumn-flowering bulb *Colchicum autumnale*, and has long been used as a remedy for gout. The easiest way to handle tiny seeds is to germinate them on water-moistened filter paper in a closed petri dish, and then transfer them as soon as the cotyledons expand to a petri dish that is kept moist with 0.5-1.0% aqueous colchicine solution. Place the seedlings upside down on the filter paper so as not to treat the roots. Concentrations as low as 0.01% can be effective in doubling chromosome number; the optimal concentration will depend upon the nature and maturity of the material treated, as well as the length of time it is exposed to the solution. One or two dissecting needles are the best transfer tools, and the closed petri dish containing the colchicine-treated seedlings should be kept under fluorescent lights for about 24 hours. Then transfer the seedlings to sterile growing media, such as a soilless mix. Since colchicine is poisonous, avoid getting the solution on your skin. If you do come in contact with it, wash it off promptly.

Larger seedlings or mature plants can be treated by applying the solution to the growing point with a medicine dropper. It is most important to be sure that the very youngest leaves are being treated. This may be done by covering the growing point with a wad of absorbent cotton kept moist with the solution for several days. The tip of an older plant may be bent over and kept immersed in a container of the solution. If the foliage tends to be waxy or pubescent, a wetting agent

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Colchicine is available from the following: ICN Nutrional Biochemicals Corp., 26201 Miles Rd., Cleveland, Ohio 44128; Calbiochem, 10933 N. Torrey Pines Rd., La Jolla, Calif. 92037; Fisher Scientific Co., 711 Forbes Ave., Pittsburgh, Pa. 15219. Cost is about $25 per gram.

such as a mild kitchen detergent can be added to the colchicine solution. No more than a drop of the former per tablespoonful of the latter is needed.

Plants whose chromosome number has been doubled by colchicine often have thicker, broader leaves and flower parts and larger leaf stomates. This is particularly true when the original plant is diploid and the treated version tetraploid. Sometimes colchicine treatment of a diploid results in greater than tetraploid chromosome numbers (such as octoploid), or the plant to be treated is already a polyploid. In these instances the derived types have more than the tetraploid chromosome number, and there may be little or no effect on leaf and flower size and shape by comparison with the tetraploid. When colchicine-treated plants show no difference from the original type, however, it is more likely that chromosome doubling was not successful. Then a stronger solution or a longer treatment time must be used. Distorted plant types, usually the result of unbalanced chromosome numbers, can be obtained from colchicine treatment; these should be discarded.

There are several reasons for wanting to double the chromosome number with colchicine. Flowers of tetraploids often are more attractive than those of diploids because they are larger and, having greater substance, longer lasting. This is true, for instance, in iris where in a few decades there has been an almost complete shift from diploid to tetraploid cultivars of the tall bearded types, even though this was accomplished through naturally occurring tetraploids.

A second major reason for doubling chromosome number with colchicine is to make fertile tetraploids from sterile diploid hybrids. This is only successful when the hybrid is sterile from lack of chromosome pairing, so that viable pollen and eggs are not formed. The tetraploid is fertile because each chromosome has an identical pairing partner in meiosis. An additional feature of such fertile tetraploids is that they usually breed true from seed.

Radiation from X-rays or gamma rays and more recently chemical mutagens have come into prominence as means of inducing mutations useful to the plant breeder. Because these agents can induce mutations in humans also, they are dangerous to the inexperienced user and should be left to the professional breeder. This represents no great deprivation to the amateur, however, because until recently few useful traits had been induced by these agents in comparison with the wide range of genetic variability available in species and cultivars for use by the hybridizer.

As you become more involved in your hobby you will find that careful records are of great use. But do not devote so much time to them that they become an onerous task. If you are growing many hybrid combinations, you may find it convenient to assign numbers to specific plants and families. With perennials your numbering system must be a non-repetitive one, so that each number is used only once. In the case of annuals, you can start over from "1" each year, adding a two-digit prefix to indicate the particular year, such as 7401-3 for the third plant in family no. 1 in 1974. Pollination tags are usually made out with the numbers or names of the female parent x male parent, plus the pollination date. String marking tags, available from stationers, are suitable and can be obtained in a selection of sizes and colors for coding purposes. Where greater durability is needed, use plastic or wired wood labels.

Further Reading

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Means and methods that may result in new begonias

NOTES FROM A BEGONIA HYBRIDIZER

Belva Nelson Kusler

IN MY APPROACH to begonia hybridizing the first requirement is imagination. From it comes the goal of what I want to produce—my dream. I might hope to put the leaf of *Begonia listida* upon a plant the size of *B. imperialis,* or the everblooming habit and large blossoms of 'Lil O'Neill' on *B. foliosa,* a species with tiny leaves.

Research comes next. Without it I risk the frustration of having spent the time and effort to produce a fine hybrid, only to find that someone has made this cross prior to my work. To avoid this, I find it wise to do research on all plants I wish to use. There is the Buxton Check List, available from the American Begonia Society, with its supplements published in *The Begonian.*

After deciding which begonias to work with, I study their characteristics, searching for descriptions wherever they can be found. If they are species, I study any progeny they might have. If hybrids, I study both parents and offspring. This search could give clues as to which characteristics of a plant are dominant and which ones are the result of a combination. I may then have some idea of how to proceed in order to produce the desired plant. However, in my work I find the results are rather variable; one cannot accurately predict the outcome. Commercial hybridizers who work with closely related plants (such as *B. semperflorens* or *B. tuberhybrida*) have a better opportunity for prediction than is possible in my frequent combinations of widely diverse types.

After the projected cross has been researched, one must acquire the plants. The next problem is to bring them into bloom simultaneously. This is not as easy as it sounds, particularly if they are seasonal bloomers—for instance, a summer and a winter bloomer. However, with the use of fluorescent lights one can frequently alter the blooming cycle so that blossoming times coincide. (*Editor's note:* But as an alternative see the remarks about storage of pollen on page 13.)

In begonias male and female parts are in separate flowers, the female flowers being borne to either side of the central male flower, which is usually smaller than the female ones, except in *tuberhybrida* types where it is larger. In many begonias the early flower clusters may have only male flowers and the later ones only female flowers.

To pollinate the flowers I take a male blossom, or a brush, and transfer the pollen to the female blossom, repeating the pollination of the latter the next day. If it is a cross that might be difficult to make, such as crossing cane begonias with rhizomatous or tuberous types, I fertilize a number of blossoms. If the plants are compatible, a seed pod may form. But if none does, that is not proof of incompatibility.

If a seed pod develops I usually leave it on until ripe and dry, but there are some begonias, *e.g., B. deliciosa,* whose blossom stems twist while drying, spilling the seeds out of the capsule. Other begonias may drop their seed pods before they are ripe. Both situations may be handled by placing a small hammock of thin plastic beneath the seed pod to catch it or the seeds as they fall. Then I

Adapted with permission from *The Begonian* 38:85-88 (April, 1971)

thresh the seeds from the dry pod, separating and discarding the chaff.

If there are many seeds from a cross, I plant only part of them, reserving the remainder as insurance in case something should destroy the seedlings. The saved seeds are placed in a sealed jar in the refrigerator. If the crossing has produced only a few seeds, I plant them all. The seed pans are put in large, closed clear plastic sweater boxes in daylight until the seedlings are ¼-1 inch tall.

If many seedlings have appeared from a given planting, I must cull at the first transplanting to reduce the volume. Since these are hybrids, there may be wide variation in the plants. Thus, I take a cross-section of the pan, including small, medium and large seedlings. If only the large and most vigorous were chosen, I might be automatically culling out the medium and small growers, or the slow.

The seedlings are transplanted from the pans into flats, moved under fluorescent lights, and kept there until they become crowded, when they are put into small pots. Later they are shifted into larger pots, at which time weak-stemmed plants, poor growers, and those with other defects are eliminated. They continue under lights until 7-9 inches tall, unless it develops that some are miniature or dwarf plants. These sometimes remain until maturity. The next move is to the window area or the greenhouse, or out-of-doors in summer in a salubrious climate.

Now the plants become most interesting. Their characteristics are established, and one sees what the mature form is like. If they have not flowered yet, growing them another year should make this aspect known. All along, I continue to cull.

At this point I propagate them and raise the cuttings along with the original plants for comparison. This is a very important step, particularly in canes or shrubby types, because a plant from seed (a hybrid as well as a species), as a rule, is considerably more shrubby than that raised from a cutting of the same plant. Therefore, one can scarcely decide from the original plant whether it is one that would ultimately be suitable for naming and distribution. Finally, the better selections must be tested under a variety of growing conditions, preferably in different parts of the country.

Perhaps the easiest crosses for the beginner to make are in the two begonia classes—*semperflorens* hybrids and *tuberhybrida,* but the chances are rather small of producing something better than, or as good as, those of the commercial hybridizers in these fields who are raising millions of plants.

Many of the cane begonia species and hybrids are exceptionally fertile and compatible, making the production of viable seed relatively easy if one is not seeking a specific goal. As an example, the species *B. dichroa* is a fine parent, easy to acquire, of small to medium stature, and a year-round bloomer with brilliant orange blossoms and medium green leaves. For years it has been used extensively in hybridizing and has produced many fine cultivars. Unless a beginner can find new species with which to cross *B. dichroa,* the chances of getting something unique are not great. If used, one could try for miniature canes, or distinctly new forms and colors of leaves and blossoms.

Dwarf Begonias

The dwarf rhizomatous begonia species and hybrids are relatively easy to work with and, if space is limited, can be accommodated more easily. *B. bowerae major* and the smaller *B. bowerae nigramarga* have been widely used, but in this class, too, there is an almost infinite number of progeny in cultivation, among them some fine named hybrids, and the chance of producing something unique is not very good.

But there is one group of dwarf begonia species, some relatively new to cultivation, from which few crosses have been produced to date. Anything really good coming from such crosses may well be the first of its kind. Among such dwarf species are *B. nurii, B. versicolor, B. violifolia, B. herbacea, B. plebeja (brooksii),* and four yellow-flowered ones: *B. quadrialata, B. prismatocarpa, B. staudtii* and *B. ficicola.*

A large plant family, including the African-violet and many others that offer hybridizing opportunities

BREEDING GESNERIADS

Carl D. Clayberg

GESNERIADS comprise a large plant family that contains more than 85 genera and 1,200 species, almost all native to the tropics. Their tropical nature makes them ideally suited to our centrally heated homes, and indeed the family contains some of the best-known house plants today: African-violets, gloxinias, cape-primroses and episcias, to name a few. It is impossible here to more than touch upon the major groups, but some of the less common genera of the family are equally worth the attention of the enterprising breeder.

Most gesneriads are so easy to propagate vegetatively that it is not necessary to obtain a cultivar that will breed true from seed. As soon as a desirable hybrid is developed, it can be propagated from stem or leaf cuttings or, in the case of gesneriads having scaly rhizomes, from scales.

In any one genus many species and cultivars that the breeder may wish to hybridize may bloom at different times of the year, often months apart. However, crosses can be made among them by storing the pollen of either parent. Gesneriad pollen stored below 32° F will remain viable for six months or more. Stored at about 40° F, it usually will not last more than two weeks, nor more than a few days at room temperature.

Gesneriads are often grouped according to the presence or absence of underground food-storage organs, similar to rhizomes or tubers, and this grouping is followed here.

Fibrous-rooted Gesneriads

The African-violet (*Saintpaulia ionantha*) is the most popular of *all* flowering house plants. It has been extensively bred, and thousands of cultivars have been named in the last several decades. The inheritance of nearly 30 important traits in the species is known. Double flowers, due to a dominant gene (D), are characteristic of today's cultivars. In addition to doubleness, the presence of this gene keeps flowers from dropping off, a conspicuous fault of older, single-flowered cultivars. Modern cultivars that appear to be single-flowered often carry one gene for double flowers (*i.e.*, are heterozygous), but have been selected for minimal expression of it, aside from flower drop. Pink flowers are due to a single recessive gene (p), and especially large-flowered cultivars are usually the result of the recessive star gene (st). Lyndon Lyon of Dolgeville, New York, one of the most successful African-violet breeders, finds that crossing single pink star cultivars with double-flowered ones of other colors gives him the widest range of variability to choose from in the offspring.

Current trends in African-violet breeding are to smaller cultivars and to combining these with trailing habit to yield miniature trailers. The trailing habit is derived primarily from *Saintpaulia grotei*, an ungainly species with very long petioles (leaf stems). But when it is crossed with the miniatures, careful selection of offspring in later generations can lead to compact miniature trailers.

Cape-primroses (*Streptocarpus*) are a varied group of species native to South Africa. The most popular strains, like the Wiesmoor hybrids, have large trumpet-shaped flowers in a wide range of colors borne above rosettes of strap-shaped leaves. Recently, the Dutch breeder, Cornelius Broertjes, has developed the compact, free-flowering Nymph series, derived by mutation breeding from the outstanding English cultivar 'Constant Nymph'.

Photographs by Carl Clayberg

Above: Achimenes 'Bright Eyes', a miniature cultivar with tuberous roots.
Right: Two gesneriads for hanging containers are *Columnea* 'Cardinal' (left) and *C. microphylla* (right), a species which offers possibilities to the plant breeder who is seeking compact or miniature hybrids.

Crosses between the best of the Nymph cultivars and the rarer color types of the Wiesmoor hybrids could lead to compact cultivars in a wider range of colors than now available.

Episcias, trailing in the manner of strawberries and with brightly colored, often variegated leaves, are favorites among house plant fanciers. The flowers also are brightly and variously colored but are usually not as showy as the leaves. Well-grown plants often are too large for most interiors; and leaf size, except for *Episcia dianthiflora,* is too large to permit well-proportioned compact plants. Compact strains would be worth developing, but *E. dianthiflora* is not an ideal breeding parent to use. For small leaves and neat trailing habit, it is unexcelled, but no one has been able to cross it successfully with the variegated-leaved types. It is also a shy bloomer. The best approach probably would be to intercross the most compact varieties and then select the smallest of the offspring. Inbreeding these selections by crossing them together should reduce hybrid vigor, giving even smaller plants in later generations.

Columneas are trailing or erect long-stemmed plants from the New World whose unusually shaped and brightly colored flowers have earned them the sobriquet "goldfish plant." This genus has been intensively bred in the last decade, resulting in many easy-to-grow, free-flowering hybrids. There is still much to be done, however. Columneas tend to flower either year-round or seasonally. Too many of the current hybrids are seasonal bloomers. The attractive, small-leaved habit of *Columnea microphylla* could be bred into more hybrids, especially compact or miniature ones. Unusual flower color patterns, like the black and yellow striping of *C. zebrina,* could be used. Because this color combination and pattern is sometimes recessive, the best way to recover it would probably be to cross *C. zebrina* with a large, yellow-flowered cultivar like 'Yellow Dragon' and then self or sib-cross the hybrids.

The Old World equivalent of *Columnea* is *Aeschynanthus.* Many species have recently been introduced into cultivation, providing the breeder with much useful material for developing good cultivars in this genus. One of the most desirable of these species for breeding purposes is *A. nummularius,* which has beautiful little heart-shaped leaves on delicate trailing stems. Although difficult to bring into bloom, it has been induced to flower under intermittent mist by W. R. Saylor of Brewster, Massachusetts, who is using it to develop some interesting hybrids.

Tuberous Gesneriads

After the African-violet, the common gloxinia (*Sinningia speciosa*) is probably the best known member of the family. It has large, velvety, usually red flowers shaped like inverted bells and grows from a fleshy underground tuber. Since its introduction from Brazil about 160 years ago, thousands of cultivars have been named, only a few of which are still in cultivation. The inheritance of few traits in this species is known, apart from some recent work I have been conducting on the genetics of flower color and color patterns. The gloxinia often grows rather large, to 1 or 2 feet across, so an important trend is towards compact, even miniature plants. Progress has been made but smaller plants are needed. In the absence of specific dwarfing genes, the best way of obtaining smaller plants is probably to intercross present compact strains, such as those developed by Buell's Greenhouses of Eastford, Connecticut, and Fischer Greenhouses, Linwood, New Jersey, following the procedure outlined for episcias.

A number of miniature tuberous gesneriads has been obtained from hybrids of two tiny relatives of the gloxinia that are in the same genus: *Sinningia pusilla* and *S. concinna.* Although neither of these miniatures will form hybrids with the gloxinia, they will cross with each other and with other species of *Sinningia* and *Rechsteineria,* a genus closely allied with *Sinningia.* Because so many species have figured in their parentage, these miniature hybrids comprise a wide range of types. Many of them are sterile, from

'Fire King', a cultivar of the common or florist's gloxinia.

a lack of chromosome pairing in meiosis, but some have been made fertile by doubling the chromosome number with colchicine. Because of their variability, it is difficult to predict the success or progeny type of a particular cross. But if these interest you, try to pick dissimilar parents. The pollen parent should be fertile, so you can obtain adequate pollen. The seed parent need not be fertile (as measured by pollen production), because even the most sterile types often develop a few viable ovules, usually by producing diploid, instead of haploid, eggs from meiosis.

Gesneriads with Scaly Rhizomes

Among the gesneriads having scaly rhizomes, achimenes (*Achimenes*) is best known and its species have been bred most intensively over the years. A wide selection of cultivars in many colors and interestingly marked faces is available. Nonetheless, much remains to be done. If plants are allowed to go dry for just a brief period, they often become dormant, dying down to the ground. Also, more compact cultivars like 'Little Beauty' need to be developed, particularly for growing under fluorescent lights where achimenes can become rather leggy.

Further Reading

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Broertjes, C. *Mutation Breeding of Streptocarpus.* Euphytica 18:333-339. 1969.

Clayberg, C. D. *Mini-gesneriads. Summary of Pedigrees of Miniature Gesneriads.* Light Garden 9(1):22. 1972.

Reed, S. C. *Genetic Check-list.* African Violet Mag. 14(3):104-106. 1961.

Unlimited opportunities exist in this varied, vast group

HYBRIDIZING AMONG THE CACTI

Philip G. Corliss, M.D.

UNTIL RECENT YEARS most hybridizing of cactus has been limited to the so-called *Epiphyllum* (orchid cactus) types, of which several thousand hybrids have been named and introduced into commerce. Crossing those species having colored flowers with the large white night-blooming species has resulted in many glorious cultivars with flowers up to 12 inches in diameter in colors of white, cream, yellow, orange, pink, red and purple, as well as bicolors and tricolors. If you have the warm, humid, shady growing conditions needed to raise these epipthytic-type cacti, you could work towards brown, green, blue, black, and better yellow flowers.

Hybridizing Opportunities

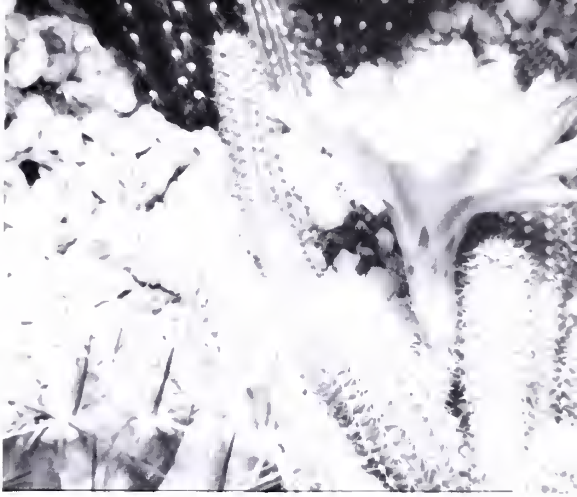
But with the desert and mountain cacti there are vast and almost untouched opportunities for hybridizing. A handful of breeders have named and introduced not more than 100 hybrid cactus, other than the epiphytic types. In the United States the main breeders to date have been Ed Hummel, Harry Johnson, Frank Reinelt, and Gil Tegelberg, all working in California.

With the recognition of some 4,000 species of cactus and the continuing discovery of many new ones in recently explored parts of South America, one might wonder why there should be a need to develop hybrids. As in most plant families, the principal goal is new flower colors, patterns and sizes. In addition, breeding can be directed towards the type of spines, which may be short or long; numerous or absent; hooked, curved, or straight; and in color variations from white through yellow, brown, red, gray, to black. Also, such factors as hair, wool, hybrid vigor, and growth habit may be considered.

I consider Frank Reinelt to be the greatest flower breeder of all time. His work with *Begonia, Primula, Delphinium, Iris, Narcissus, Echeveria* and many other genera has greatly enriched our gardens.

Photographs by George Kalmbacher

The cactus *Chamaecereus silvestrii* 'Flame' is easy to grow and crosses readily with *Lobivia*. Shown is a hybrid of this cross.



Another example of a cross between *Chamaecereus silvestrii* and *Lobivia*.

Now he is working only with cactus and his achievements to date are already too numerous to list here. He has made many intergeneric crosses with desert and Andean plants and some of his hybrid flowers are tremendous improvements on the species from which they are derived.

Harry Johnson has been especially successful in developing hybrids involving *Echinopsis* and *Lobivia* which have a wonderful color range. *Echinopsis* species are all night-blooming, the flowers occurring near the top of the plant. They are mostly large, with long tubes. With few exceptions, the flowers close early in the day in hot weather and sun and so are not very desirable garden subjects. Lobivias, on the other hand, are day bloomers; their flowers occur on the sides of the plant and often last several days. The species of these genera cross readily and the hybrids are perhaps the easiest of all cactus to raise from seed—the ideal plants, in my opinion, for the beginner. Lobivias also cross readily with the Argentinean peanuts cactus, *Chamaecereus silvestrii,* and numerous desirable hybrids from these crosses have been developed in Europe.

I would suggest starting with the following plants of the above types, which have proved to be excellent parents:

'Stars and Stripes', an *Echinopsis* hybrid of Harry Johnson having large pink flowers with rose stripes.

Lobivia marsoneri has a deep yellow cup-shaped flower and produces hybrids of great merit with *Echinopsis*.

Chamaecereus silvestrii, the peanuts cactus, is easily grown, has myriads of red flowers, and crosses easily with *Lobivia.*

'Pink and White' and 'Little Red Riding Hood' are Johnson *Lobivia* hybrids and, along with his 'White Knight', a huge white *Echinopsis* hybrid, have proved to be exciting parents for me.

In addition to the hybrid types described above, I will mention a few other kinds, if only to suggest the almost endless possibilities:

There are hybrids of *Aporocactus* (rat-tail) and *Epiphyllum* types. Their trailing stems make them suitable for hanging baskets. They have fairly long periods of bloom with large flowers in all shades of pink, red, and purple. *Heliocereus* is also used with rat-tail cactus and with the larger *Trichocereus*.

The large and glorious flowers of *Echinocereus,* the hedgehog cactus, remain open for from one to two weeks. The development of new colors and patterns (stripes and contrasting centers) in this group has hardly been started.

Cultural Tips

Cactus seeds may be planted in almost any medium. My preference is for an oven-pasteurized mixture of leafmold and sand, possibly also incorporating sphagnum moss, peat, or perlite. The pots and mix are thoroughly soaked in fungicide-algicide solution. After the seeds have been sown, the pots are enclosed in air-tight plastic bags until the size of the new plants necessitates transplanting or grafting. I use 3- or 4-inch pots and clear plastic sandwich bags with twist closures. The seedlings are thus protected against one of the greatest scourges of cactus seedlings, the larvae of the scarid fly. They require no watering or other care except adequate heat and light for from six months to one year. Be sure that cats' claws do not puncture your plastic bags!

Most cactus seedlings grow slowly, and by grafting them on a vigorous stock there will be faster growth with earlier and more profuse bloom. When mature, the cactus may be removed from the stock to develop its own roots if this is desired, although some cultivars are difficult to grow outside of their habitat and should always be grown as grafted plants.

The literature abounds with recommendations for specific combinations of stock and scion, but I believe almost any cactus will accept another as scion. The important thing is to use a stock that is vigorous for your conditions. With me, this is the *Echinopsis* group—the kind known as Easter lily cactus. I grow the common ones and fertilize them heavily to produce numerous offsets which are easily detached and rooted for use as grafting stock. Various *Cereus, Trichocereus, Myrtillocactus, Opuntia, Nyctocereus, Hylocereus, Harrisia, Selenicereus* and other genera also make satisfactory stock.

Books on Cacti

Most books about cactus contain chapters on culture, growing from seed, grafting, and other useful information for the amateur breeder. The best source for cactus books in the United States is Abbey Garden Press, 1593 Las Canoas Rd., Santa Barbara, California 93105. Its annual free catalog lists all cactus and succulent books in print. From the current list I recommend the following as most useful to the amateur breeder:

The Cactaceae. Britton and Rose. 2 vols. reprint. 1,048 pp., 1,250 illus.

Cacti. J. Borg. 1970. 512 pp., 128 illus.

Cacti and Succulents. W. Haage. 1963. 264 pp., 900 illus.

The Book of Cacti and Other Succulents. C. Chidamian. 1958. 258 pp., illus.

Cacti and Other Succulents. S. H. Scott. 1959. 160 pp., illus. ⁂

An Acre of Glass on Rails

THE Meilland firm of France is acknowledged as one of the world's leaders in the breeding of roses, but few people in North America realize the size of its operation. For example, its breeding establishment uses 10 acres of glass in the hybridizing and testing of new rose cultivars. There can be as many as 150,000 plants under test at any one time, yet the firm plans on bringing out no more than four new cultivars each year.

One of the most interesting sections of the Meilland rose testing system is a range of glass, covering an entire acre, which is mounted on rails and is moved from one part of the test field to another as the crop conditions demand.

The capital invested in this enterprise is enormous and has been made possible only by the patent and/or plant royalties systems now in almost universal use throughout the rose world. For example, the royalties on the four chosen introductions will have to carry all the costs of producing and observing those 150,000 seedlings.

Adapted with permission from *Canadian Florists Greenhouse and Nursery,* September 15, 1973.

CACTUS GRAFTING

Philip G. Corliss, M.D.

THE EASIEST and probably most common type is the flat or horizontal graft. Stock and scion should be of the same diameter, but this is not vital as long as both are in healthy growing condition, and viable areas of both are in contact at the graft junction so the scion can receive sap from the stock. Pressure is maintained between opposing surfaces until the union is strong (usually about two weeks) by rubber bands (size #19 is best). These hold the scion to the stock by its spines or by being passed under the pot.

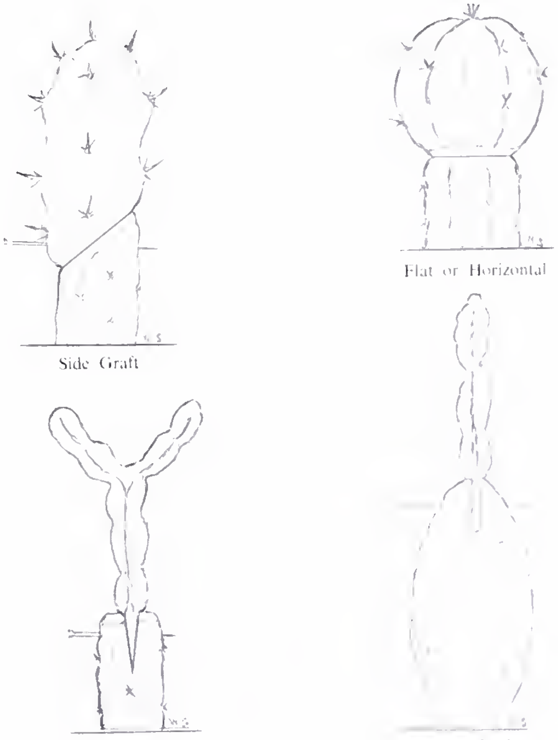
To unite slender epiphytic cacti to stocks, such as *Opuntia* pads, the cleft graft is best, or its variant the stab graft. Another variant is the wedge graft, in which the cuts are made at a broader angle.

Two others are the plug graft and the side graft. The latter permits the opposition of large surface of stock and scion when one or both may be rather slender. It is often used for scions such as *Wilcoxia* and *Aporophyllum*.

Union in all types, except for the flat graft, is maintained by cactus spines; rubber bands are not needed. Spines from any cactus will do, but the easily grown *Opuntia* species are best, especially *O. subulata* and *O. elata.* Cactus spines do not cause undesirable tissue reactions as would happen with foreign bodies like metal pins. After satisfactory union the spines may be clipped where they project.

In grafting, surgical asepsis should be observed; and the optimum growing conditions concerning light, temperature and humidity are important.

Four Kinds of Grafting Techniques for Cactus Plants



Side Graft

Flat or Horizontal

Cleft Graft

Plug Graft

There is an intense satisfaction in creating a new rose . . .

ROSE BREEDING

William Warriner

IN PLANT BREEDING the emphasis has long been on providing for the staggering requirements of a Malthusian population increase. Justifiably concerned governments, research foundations and universities have expended huge funds and countless man-hours to achieve greater production and yield of food crops. In the process, roses, as well as other ornamental plants, have received relatively little attention. There is no mapping of the genes; very little is known of the linkages that occur, the nature of such things as inheritance of fragrance, thorniness and growth habit. But despite the absence of purely scientific knowledge, an amateur gardener can become highly proficient in the art and science of rose breeding.

The objectives of rose hybridizers vary depending on the scope of the project, but there must be specific goals to give direction to the work. A person breeding roses on a small scale should try to work in only one direction, such as development of low-growing floribundas, thornless hybrid teas, or hardiness. Larger programs —amateur or commercial—require numerous objectives.

Choosing the Parents

Once the objective has been defined, the hybridizer can select a number of cultivars which seem best suited to contribute the right combinations of factors to achieve it. It seems that most, if not all, of the characteristics or criteria by which we judge roses are influenced by a number of genes which may or may not be closely linked; therefore, it is very difficult to establish the dominance or recessiveness of any one factor. Selection of parent cultivars is one of the two most important steps in rose hybridizing; the other is seedling selection.

There have been many comments by rose breeders that certain traits, such as flower color, form and size, are inherited through the pollen parent and other traits through the seed parent. Work with species has seemed to indicate some kind of male dominance, the pollen parents transmitting more traits than seed parents. Among hybrid roses, the opposite can be demonstrated by making reciprocal crosses and observing similar populations from each. Whether a parent cultivar is used for pollen or seed will depend on simple factors such as its fertility, pollen production, and arbitrary preference. Usually, good varieties will be used both ways.

Numerous articles have elaborated on the importance of bringing new species into rose breeding and reusing some that are again available. These accounts make interesting reading and no doubt there is something to be gained from species breeding in the area of disease resistance and possibly color breaks, but the road is long and hard. In present-day garden varieties, there are enough uncombined characteristics to keep one busy selecting parents for a lifetime.

After hybridizing roses for a number of years and watching the results of other hybridizers, the breeder will see from time to time the tantalizing characteristics of the ideal cultivar; tantalizing because these characteristics will be spread over many cultivars, named or unnamed, and over a span of time. Then there is the problem of trying to recombine all the desired traits, while eliminating the undesired ones, into one cultivar or a series of cultivars.

Parents are selected by trial and error, depending on the quality of their seedlings. Some parent cultivars are used for one outstanding trait only, such as flower color or petal substance. When crossed with cultivars lacking in this trait, but possessing other good genes, some of the seedlings will combine desirable traits from both sides. Often the opposite occurs, or the good trait remains doggedly linked with one that is unwanted. For example, we once selected a seedling to be a parent because of its outstanding dark green, disease-free foliage, heavily branched habit and good red color. It set seed very freely and the seed germinated well. But from thousands of progeny, only a few seedlings were chosen for further tests or crossing because of a very persistent (or dominant) trait of a thin, weak neck.

Seeds

After selecting parent cultivars, the next task is producing seedlings. The mechanics of pollinating and pollen growth are not discussed in this article since basically they are the same for most plants and the general subject is treated on pages 12-15 of this Handbook. Seed collection, sowing and growth of rose seedlings are discussed as they may differ from other genera that are covered.

Hips, the name commonly given to the seed-bearing fruit of roses, ripen two to three months after pollination. They must be watched closely to prevent their loss by falling or their being eaten by mice or squirrels. Hips should be collected before they absciss (separate naturally from the plant after ripening) and the seeds removed with a knife. If there are many hips to collect over a period of several weeks, they may be stored in a cool, dry place until all of the remaining hips have been gathered.

Another method of handling seeds is to place them in a plastic bag containing moist peat moss and store them in a refrigerator at normal home refrigerator temperature, about 40° F. There should be no excess moisture in the bag, just enough to keep the peat and seeds damp. Watch seeds stored in this manner closely, because in about six weeks sprouting may occur and the seeds should be planted. This is a very convenient method of initiating germination, whether seeds are collected and dried for a few weeks or processed immediately. It eliminates five or six weeks of care and watering of seed beds. Leaching seeds for five or six days in running or frequently changed water before planting seems to aid germination.

Seeds are preferably germinated in a cool greenhouse but small lots can be successfully germinated in a cool basement or other room under artificial light. A light, easily managed medium such as sand and peat moss is best. Since ger-

William Warriner, research director for the Jackson and Perkins Company, spends much of his time evaluating and selecting rose seedlings.

mination may take several months, a covering of plain sand will help reduce growth of moss and algae. Seeds sown about ¾ inch deep and kept moist will germinate at various times—from a few weeks to over one year. Germination slows during the summer, and some seeds that fail to germinate will often do so at the onset of cooler weather.

Care of Seedlings

Two systems should be considered for growing seedlings, with the choice contingent on your particular situation. The first system is the transplant-and-line-out method. Small seedlings with only two or three leaves can easily be lifted out, placed in a light potting mix, and grown to lining-out size, when the second or third flower has opened. These can then be either lined out in the garden or transplanted to larger containers for evaluation and study.

The second system requires the use of potted or field-planted understocks. In this system, seeds are sown in beds or benches in rows 6 to 12 inches apart. The seedlings are allowed to grow and flower in place. Initial evaluation and discarding must be started with the first set of blooms, about eight weeks after germination. Discarding seedlings that are single-flowered or have poor color or form allows more room for the better seedlings to develop. Selected seedlings can be budded during the summer to previously started understock. By autumn these seedlings usually will be well spaced in the bench and can be easily lifted with a large ball of roots and potted if you want to save the original plants for the test garden.

This second method permits the growing and evaluation of more seedlings with less labor than the transplanting system. If the hybridizer wants to study inheritance patterns in seedling populations, he must record descriptions of each discarded seedling since he cannot have them in bloom all at once.

During germination, it is sometimes necessary to treat for "damping-off" disease caused by one or more fungi. Even though the starting medium is sterilized, pathogens usually invade the beds or flats before germination is complete. It is usually desirable also to fertilize with liquid fertilizer to keep the small seedlings growing well.

Once the seedlings have begun to bloom, the most critical and difficult part of hybridizing begins—selecting seedlings. The first flowers appear on bush-type seedlings within eight to twelve weeks, when the plants are only a few inches tall. It is at this stage, when the first or second flower opens, that discarding must begin. A beginning hybridizer should save many seedlings that are not really good, remembering or recording the bloom quality from first flower to the end of the first season. This is perhaps the best way to learn what to keep and what to discard.

All seedlings showing promise should be grown into full-size plants, on their own roots or as budded plants. The second and subsequent years are spent in further selection, retaining varieties that continue to show promise, discarding those in which too many defects appear. Often, large numbers of a clone are grown to learn plant habit, disease resistance, quantity of blooms, and other characteristics.

When looking at seedlings, keep in mind the performance of the parents: how does each transmit its good traits or its bad ones? Be alert also for new parents among the seedlings. Unnamed, undistributed seedlings give the hybridizer his "private stock," available to no one else.

Obviously, accurate records of parentage are essential. Develop a simple system for referring to the backgrounds of each seedling and for occasional checks on the performance of each parent. These will be more than records, they will be an accounting of your frustrations—and pleasure. The "perfect" rose is often the elusive rainbow—near, lovely, but just beyond reach. Perfection notwithstanding, there is an intense satisfaction, seldom experienced in any other endeavor, in creating a unique new rose.

Many fanciers are developing their own cultivars for the distinction they may lend to their own gardens

DAFFODIL BREEDING IN AMERICA

Grant E. Mitsch

SINCE THE PUBLICATION of the first Brooklyn Botanic Garden Handbook on plant breeding in 1959, a great change has occurred in the outlook for American-bred daffodils. Perhaps no startling innovations have appeared, but with the dissemination of information through horticultural periodicals, especially those of the American Daffodil Society and its affiliates, many fanciers have become engrossed in developing their own cultivars for the distinction that such plants may lend to their own gardens. Some enthusiasts also hope that one or more of their clones may take a place in commerce. Undoubtedly, the number of daffodil breeders would be considerably augmented were it not for the lapse of twelve to fifteen years from the sowing of the seed to the accumulation of a stock sufficient to start distribution.

Exhibition Flowers or Adaptability?

Over the past century, the best daffodils came generally from hybridizers in Great Britain. Breeders and fanciers were often patrons of the shows sponsored there, and major emphasis was given to exhibition-type flowers. Because the largest and most striking flowers are members of the first three divisions (see page 30) of the Royal Horticultural Society's daffodil classification system, which is recognized internationally, the other eight classes were neglected by many breeders. This situation is now being remedied both in Great Britain and the United States. There is still much room for improvement in all sections, but introductions of the last fifteen years demonstrate broader vision and more cosmopolitan tastes.

Show flowers should not be depreciated, but those which must be grown under glass, or given protection and shade by one of the many devices that overseas growers use, are unlikely to find favor in this country. American gardeners are not inclined to give so much in trouble, time and expense to produce a few show blooms. Furthermore, judging committees tend to frown on entries grown artificially.

The majority of daffodils raised in the moist, cool climates of Great Britain, Holland and our Pacific Northwest seem to thrive in most places where daffodils can be grown. However, often enough they do not take kindly to the harsh conditions prevailing in many parts of the United States. Thus, apart from hybridizing for purely floral characteristics, amateur breeders in such areas should be encouraged to raise seedlings and select clones that are well adapted to their own regions.

Developments in the Northwest

Here in Oregon we have been breeding daffodils about forty years. Starting with a few yellow trumpets, we have broadened our scope until now nearly all classes receive some attention. More consideration has been given to "pinks" than any other group. In many years, several thousand seeds of pink crosses are sown. These represent not only attempts to produce the conventional trumpets and large cups, but also various species hybrids. Originally, depth of color was a prime consideration, and it is still important, as some of the nearest approaches to a red daffodil come through this avenue. Of course, a great many shades of salmon, apricot, buff, and nearly true pink come from such breeding.

Form, substance and vigor also require

scrutiny, and a good stem and poise are essential. Flaring and ruffled coronas enhance the flower's value for cutting, although they are perhaps unimportant in the exhibitor's code. 'Accent', with its bright salmon-rose crown, is a new popular cultivar. Other "pinks" are 'Caro Nome' and 'Precedent,' which have less color but develop good show form. For sheer beauty 'Coral Ribbon' and 'Audubon' rank near the top.

Reversed bicolors are a comparatively recent development, and some of our most successful daffodils fall in this group. The luminous shades of yellow are an outstanding attribute, and as the crowns or trumpets fade to nearly white, a new distinctive and elegant asset is added. 'Daydream' is a highly esteemed show flower and is unsurpassed for garden effect, although difficult to grow in some of the warmer parts of the United States. Paler in color are 'Lunar Sea' and 'Honeybird', with coronas long enough to be classed as trumpets. Not being satisfied to have all such cultivars in trumpets and large cups, we wanted to incorporate these beautiful colorings in other classi-

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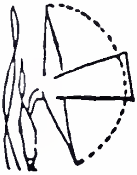
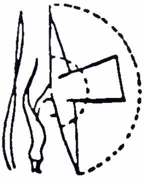
The Royal Horticultural Society's

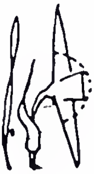
DAFFODIL CLASSIFICATION



Division I TRUMPET DAFFODILS:
The trumpet or corona is as long as or longer than the perianth segments.
(a) Perianth colored; corona colored not paler than the perianth.
(b) Perianth white; corona colored.
(c) Perianth white; corona white, not paler than perianth.
(d) Any color combination not falling into (a), (b) or (c).



Division II LARGE-CUPPED DAFFODILS:
The cup or corona is more than one-third, but less than equal to the length of the perianth.
(a) Perianth colored; corona colored not paler than the perianth.
(b) Perianth white; corona colored.
(c) Perianth white; corona white, not paler than perianth.
(d) Any color combination not falling into (a), (b) or (c).



Division III SMALL-CUPPED DAFFODILS:
The cup or corona is not more than one-third the length of the perianth segments.
(a) Perianth colored; corona colored not paler than the perianth.
(b) Perianth white; corona colored.
(c) Perianth white; corona white, not paler than perianth.
(d) Any color combination not falling into (a), (b) or (c).

Division IV DOUBLE DAFFODILS:
No cup, trumpet or corona is visible as such. Although two distinct types of petals may be noted, they are usually twisted and intermingled. The flower may be of one color or bicolored.

Division V TRIANDRUS HYBRIDS:
Characteristics of *Narcissus triandrus* clearly evident. Flowers nodding, usually several to stem and white or pale yellow. Corona usually bowl-shaped, perianth reflexed, of silky texture.
(a) Cup or corona not less than two-thirds the length of the perianth segments.
(b) Cup or corona less than two-thirds the length of the perianth segments.

fications. The jonquil hybrids were first to show success and a series with birds' names evolved, among them 'Pipit', 'Verdin' and 'Dickcissel'. Cyclamineus and triandrus hybrids are coming along. An objective now is to produce similar flowers whose blooms open with the corona white so we won't have to wait for several days for it to fade.

Other Hybrids

Unfortunately most jonquil and triandrus hybrids are sterile or very nearly so, and this hinders progress in these classes. A few will occasionally produce viable seed and/or pollen, and from these some interesting second-generation hybrids have been produced. 'Quick Step' provided an interesting and useful exception to the rule, and it was the first jonquil hybrid seen here that produced an abundance of seed—whether hand pollinated or not. Crossed with 'Daydream' and 'Accent', it produced seedlings much larger than itself and with some of the color of the pollen parents. With pollen of *Narcissus triandrus albus* it produced quantities of floriferous progeny suggesting in form the

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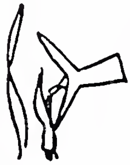

Division VI CYCLAMINEUS HYBRIDS:
Characteristics of *N. cyclamineus* clearly evident. Flowers usually nodding, single, yellow, with narrow corona and sharply reflexed perianth.
(a) Cup or corona not less than two-thirds the length of the perianth segments.
(b) Cup or corona less than two-thirds the length of the perianth segments.

Division VII JONQUILLA HYBRIDS:
Characteristics of any of the *N. jonquilla* group clearly evident. Flowers usually several to stem, with short cup and flat perianth, bright yellow, sometimes fragrant.
(a) Cup or corona not less than two-third the length of the perianth segments.
(b) Cup or corona less than two-thirds the length of the perianth segments.

Division VIII TAZETTA HYBRIDS:
Characteristics of any of the *N. tazetta* group clearly evident. Usually two to six or more small, very fragrant flowers with very short cup and rounded flat perianth, often somewhat crinkled.

Division IX POETICUS HYBRIDS:
Characteristics of the *N. poeticus* group without admixture of any other. One flower to stem, with glistening white perianth and very small flat cup usually yellow or green with red edge.

Division X SPECIES AND WILD FORMS AND HYBRIDS:
Includes all varieties presumed to have originated in the wild, as opposed to varieties originating in gardens.

Division XI MISCELLANEOUS
To include varieties of garden origin not covered in Divisions I-IX. At present this Division contains only a few varieties, chiefly Bulbocodium hybrids.

triandrus species. Open pollinated blooms of 'Quick Step' (presumably selfed) resulted in almost exact replicas of itself.

Tazetta and poets were at one time among the most popular of the narcissus genus, but comparatively little work has been done with them recently, perhaps because of sterility in most of the former, and insufficient variation in the latter. Interest is reviving, and it was found that the tazetta, 'Matador', sets seed quite readily some years. Crossed with jonquilla it has given a series of lovely flowers showing characteristics of both parents. It may be difficult to classify them in the correct category. Breeders who like controversy may find this a fertile field of endeavor! Several hybridizers are working with the poeticus group, but no great amount of success has been achieved here.

More daffodils are found in the large-cupped division than any other, and there is doubtless still more effort expended here than elsewhere. 'Festivity', coming from an undetermined cross, has achieved first place in the popularity rating, and has proven a good show flower as well as an excellent garden subject. Other divisions have not been neglected and such flowers as 'Aircastle', 'Cool Crystal', 'Silken Sails', 'Jetfire' and others are gaining acceptance.

There are now a dozen or more breeders in Oregon alone, and with the many others working here in the West, along the Atlantic seaboard, in the southern states and in the Midwest, there is certainly promise of a wider range of daffodils adapted to all sections of the country within a few years. ✤

Marjorie J. Dietz

The daffodil is one of the most popular of spring-blooming bulbs for home and public gardens because of its lengthy flowering period and the ability of most varieties to endure the vagaries of late winter and spring weather. Breeders continue to strive for daffodils of ever more rugged constitutions.

"Perhaps the only perennial that flourishes in all fifty states . . ."

HEMEROCALLIS

Philip G. Corliss, M.D.

I HAVE LONG CONSIDERED the day-lily (*Hemerocallis*) to be unsurpassed as a subject for the amateur plant breeder. All the steps from pollen daubing to blooming of the hybrids are easy; it is one of the few perennial flowers that can be brought into bloom in two years; it is perhaps the only perennial that flourishes in all of the fifty states. The possible variants number billions. This is amazing when one considers that there are less than a score of species, none of them with color other than yellow or orange except the sterile double *H. kwanso* and the nearly sterile *H. fulva*, which is the "tawny" day-lily of gardens. From the genes of the latter have come all of today's melon, pink, red and purple flowers.

Hemerocallis breeding today is in a state of flux due to the current interest in tetraploid hybrids, many of which are now commercially available. Seeds and seedlings of diploids as well as mature diploid plants may be treated with colchicine (see page 14) to produce tetraploids or chimeras. Seed production, germination, and viability of the tetraploids were difficult at the start but there has been tremendous improvement lately. As with tetraploid iris, the advantages over the diploids are in more vigorous-growing, heavier-substanced and more floriferous cultivars. It is confidently expected that further work will bring new flower forms, colors and patterns.

As with all hybrid plants, the amateur breeder should work with the finest available cultivars. The choicest new introductions, especially tetraploids, may cost fifty dollars or more; but the price drops rapidly each year after introduction. By choosing two or more cultivars which seem to have promise as good parents for the type of flower he seeks, the amateur can undertake his breeding for a modest outlay. In fact, the breeder who works chiefly for his own pleasure can find excellent diploid parents at hemerocallis nurseries for not more than one dollar each; good tetraploid cultivars are already being offered at less than five dollars.

Breeding Goals

Some objectives are:

(1) Color. There is a need for better white, blue, green, brown, and black flowers.

(2) Everblooming or remontant characteristics. This is very important for, although hemerocallis foliage may be attractive most of the time, a common complaint is that there is too much foliage for the amount of bloom. The tetraploids give more bloom and if ever-blooming tetraploids can be developed they will be most welcome.

(3) Color pattern. Contrasting eye zones, stripes, edging and stippling provide variety in hemerocallis flowers.

(4) Size. Either miniature or giant flowers, for example, may be a breeder's prime objective.

(5) Multiflora types. The heavily branched day-lily with many open flowers is a type which has been largely neglected by breeders in recent years.

(6) Height of bloom scape. Although it is generally considered that a good day-lily should have a flower in pleasing proportion to its height, there have been some good dwarf cultivars with large flowers and some fine tall cultivars with a profusion of small blooms.

(7) Resistance to fading, substance to withstand inclement weather, and ability to withstand vicissitudes of culture or disease are possible goals.

(8) Breeding for good performance of the type you like in your region may be worthwhile, as your favorite type may not be available in a cultivar suitable for your particular conditions.

(9) Breeding for early- or late-season bloomers. The development of remontant or continuous bloomers should eliminate the need for these, but there is still a need for superior varieties that will bloom at both ends of the season.

(10) Fragrance. This is an attribute of night-bloomers in many plant families. It is useful in attracting pollinators. Night-bloomers are also usually light in color for the same reason. *H. citrina* is the hemerocallis species from which fragrance in hybrids has been derived. An occasional back-cross to *H. citrina* might be useful in strengthening this factor. It should be noted that the blooming time of hybrids between nocturnal and diurnal varieties is not predictable. Some will be night-bloomers, others diurnal, and some will have irregular or "in-between" blooming times.

(11) Flower opening time. The factors noted in (10) apply here and, in addition, there is a definite need for "extended bloomers," which are cultivars whose flowers remain open until well into the evening, not closing at sundown. Such types are desirable where flowers are used indoors in arrangements in the evening, or for planting in patios, swimming pool areas and around porches used in the evening. The originators' descriptions of registered clones will give information on cultivars useful in this field.

(12) Double flowers are admired by many. I prefer singles in all plant families, as doubleness hides (or eliminates) the reproductive parts and also masks any contrasting color pattern of the segments. There are some truly double hybrids. Further work in this field might be rewarding.

There are a few things about breeding hemerocallis that do not always apply with other plants. Most important is the factor of regional performance. While there are some which will grow in all fifty states, not all cultivars will do well everywhere. Winter-dormant cultivars are best for cold climates and evergreen ones best for frost-free climates. There are many further variations in performance, some perhaps subtle, such as ability to withstand wind, drought, flood, shade, sun or different soil conditions. Originations of our leading breeders have usually performed best in gardens of similar climates.

The seeds of winter-dormant cultivars should be planted in cold frames or refrigerated before sowing. No special treatment is required for seeds of evergreen cultivars. Seeds of day-lilies may be grown in containers such as coffee cans in the house during the winter in cold climates. I should warn you that small seedlings may need protection from birds. They will often uproot entire beds of seedlings in one day, not eating them but just pulling them out of the ground. Also, while rich soil and fertilizers may be desirable, the greatest need of hemerocallis is for plenty of water.

Membership in The American Hemerocallis Society includes quarterly journals which are filled with the most recent breeding information. From the Society may be obtained lists of nurseries specializing in hemerocallis and such other aids as check lists of registered clones. Membership facilitates visits to other day-lily growers, local, regional and national meetings, and the many hemerocallis shows sponsored by the Society.

At this writing, my book is the only one on hemerocallis currently in print. It contains a chapter on hybridizing and pertinent information for amateur breeders. The other sources listed below can be found in many public libraries.

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"The major need of modern gladiolus is increased resistance to diseases . . ."

GLADIOLUS BREEDING

Gary J. Wilfret

GLADIOLUS, grown in many areas of the world either for cut flowers or for garden displays, offers plant breeders a range of genetic variability to manipulate with simple hybridizing techniques. Numerous forms are under cultivation, embracing the large exhibition types standing 6 feet tall with twenty-thirty 6-inch florets to the miniatures with 1-inch florets.

Most gladiolus breeders use the modern hybrid cultivars whose complex genetic background provides an excellent source of genetic variation. Floret colors range from white to dark purple, encompassing most shades of yellow, pink and red. Only dark blue is conspicuously missing from the modern cultivars. Petal structure varies from plain to heavy ruffling; substance varies from light to extremely heavy; and floret types vary from round to triangular, cupped to wide-open.

Over 10,000 cultivars have been recorded during the past 200 years, from a gene pool of only 15 of the 150 gladiolus species known. The potential genetic variability would be enormous if the 135 unused species could be incorporated into a breeding program. Although most gladiolus cultivars are tetraploid (60 chromosomes), somatic numbers in the species vary from diploid (30 chromosomes) to octoploid (120 chromosomes).

A few perceptive breeders are trying to incorporate new species into their programs. In addition to intra-generic hybrids, it has been found that certain intergeneric hybrids are possible with gladiolus. *Homoglossum* and *Acidanthera* species have been successfully crossed with *Gladiolus*, indicating an additional source of genetic variability. (See page 39.)

Mutations in gladiolus cultivars are relatively common, especially in floret color. Generally the mutants are lighter in color than the originals and a few have made outstanding contributions to the gladiolus world, such as 'White Friendship'. This cultivar and the original 'Friendship' comprise between 40 and 50 percent of the cut flower crop produced in the United States. Most color mutations are simple chimeras with no effect on the germ cells. Attempts at inducing mutations with irradiation or chemicals have had limited success, with most of the mutations being horticultural freaks.

The Gladiolus Flower

Each floret contains three sepals and three petals (collectively called tepals when indistinguishable) surrounding three stamens, whose anthers bear the pollen, and a single tricarpeled pistil with a three-forked stigma. The ovary contains between 75 and 150 ovules. The anthers dehisce within 3-4 hours after the tepals unfurl, with most of the pollen falling on the ground or landing on the lower tepals or lip of the floret. The stigma stands some distance above the anthers and is not receptive until it becomes feathery, generally within 24 hours after the pollen is shed.

Hybridizing Technique

In many cultivars the style begins to curl downward on the third day, bringing the receptive stigma in contact with the anthers and any adhering pollen. This provides opportunity for self-pollination, one of the main concerns in gladiolus hybridizing. Natural cross-pollination is rare, as the pollen is heavy and is not carried about by the wind, and bees rarely contact the stigma.

Each floret which is to be used as the

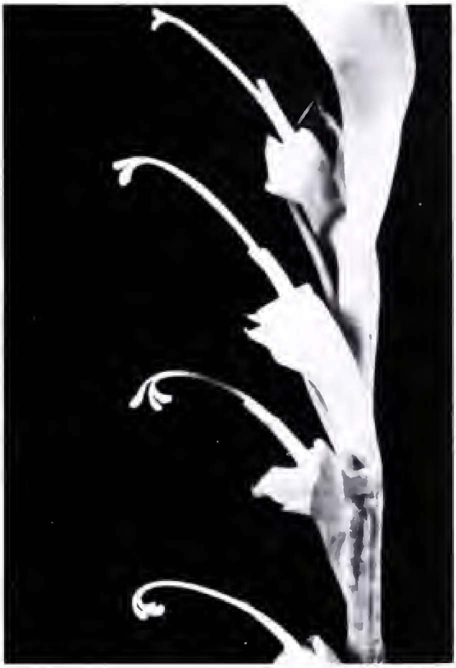

Fig. 1 A gladiolus flower spike with emasculated florets ready for pollination.

seed parent must be emasculated prior to the unfurling of the tepals. All tepals and stamens must be removed, exposing the single pistil (Figure 1). When the stigma is receptive, pollen from the male parent is dusted on the sticky stigmatic surface. This process is repeated the following day to insure pollination. The easiest method of pollination is by simply brushing the stigma with an anther which has pollen adhering to it. Pollen can also be collected and stored up to three months in a refrigerator for later use. If the pollination is a success, the style will begin to wilt within 48 hours. Generally pollination is more successful in the mornings before the stigmatic surface dries completely.

Five to ten florets on a spike should be used for each cross and at least two spikes pollinated to insure against loss of one due to disease or breakage in the field. The spike should be broken off above the last floret pollinated and then staked to prevent breakage. Label each spike so the pedigree can be retained.

Four to five weeks after pollination the fruit is mature and ready for harvest as soon as it begins to split. If left too long in the field, the seed may become diseased or be blown away by the wind. When dried, the fruit is split open and the seeds are removed. A maximum of 90-100 viable seeds can be expected per fruit from a successful pollination, although the number varies with the cross. Place the seed in envelopes which are labeled as to the cross number, and store in a cool dry location until planting. If weather permits, it can be planted immediately after harvest because no seed dormancy exists in gladiolus.

Prior to planting, seed should be rubbed between two layers of cloth to remove the waxy covering or "wing." This allows better contact of the seed with the available soil moisture and increases germination. Three to four weeks prior to sowing the seed, till and fumigate the soil to eliminate any insects or disease organisms which might destroy the young seedlings. Seed should be sown after the last frost in 1-inch-deep furrows with individual seeds no closer than one-quarter inch to allow development of large corms. Cover the seed beds with a light mulch of sawdust or peat moss to prevent drying of the soil and discourage weeds. Adequate moisture is critical during the first six weeks when the young roots and shoots are developing. Shoots will emerge within four weeks (Figure 2). Seedlings must be fertilized and sprayed with insecticides and fungicides regularly to obtain maximum-sized corms the first season.

Major problems encountered in the seed beds are cutworms and loopers which chew the young leaves, aphids and thrips which can transmit virus particles, and *Curvularia* fungus which rots the shoots at the soil line. All of these can be prevented by adequate sprays.

If the seedlings are given good care, many of the corms will be one-half to three-quarters of an inch in diameter

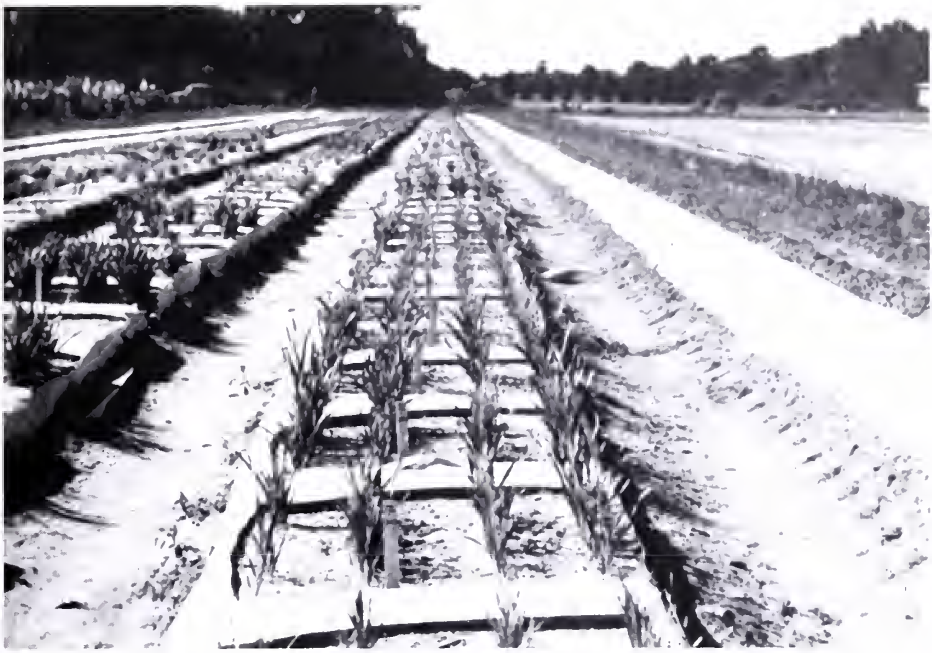

Fig. 2. Gladiolus emerge within four weeks of sowing. These seedlings are eight weeks old.

within six months. Corms are dug, cleaned, dipped in fungicides, dried and stored in the same manner as other gladiolus corms. The following year the seedling corms are grown and the flowers are evaluated. Some selections are made the first year but generally all corms, except the obviously inferior ones, are dug and replanted the following year for a second evaluation. Selections are stored individually and are labeled as to cross number and selection. Normally less than one percent of the corms are saved for evaluation beyond the third season.

Breeding Objectives

Goals of the gladiolus breeder depend upon the market he is seeking for his seedling. Very large markets exist for commercial cut flowers or exhibition types (Figures 3). There is less demand for novelty types such as doubles or multi-branched spikes. Exhibition spikes must meet rigid standards set by national gladiolus societies. The breeder considers number of florets, placement, texture, ruffling, color clarity, flower size, spike length and symmetry, and vigor.

Some modern cultivars which have produced excellent progeny for exhibition use are: 'Butterball', 'September Song', 'Happiness', 'Pink Prospector', 'Caribbean', 'Snow Velvet', 'Partly Ruffles' and 'Sunkist'. Essential criteria for cut flowers are: uniform spike length throughout the year, ability to open when cut in the tight bud stage, flower size, color clarity and disease tolerance. Among the cultivars which should be tried as parents for cut flowers are: 'Friendship', 'Traveler' and 'Minaret'.

Many of the present commercial cut-flower cultivars such as 'Valeria', 'Spic & Span', and 'T-590' should be avoided due to their high susceptibility to disease. 'Hopman's Glory' and 'Beverly Ann' are two cultivars which are very resistant to *Fusarium* wilt disease but need to be improved for their flower characteristics. Most cultivars with 'Picardy' in their an-

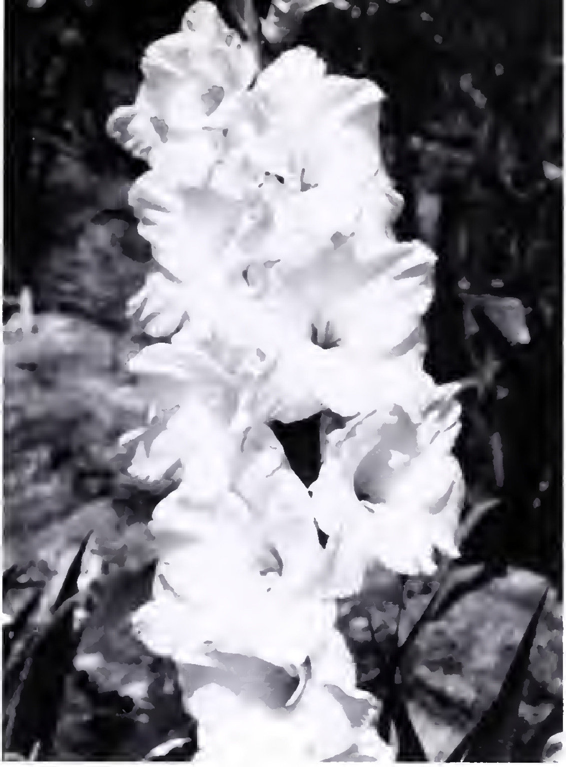

Fig. 3 A flower spike of a seedling gladiolus that is suitable for exhibition use.

cestry should be avoided due to the susceptibility of this cultivar to *Fusarium*. Although improvements are needed in many color classes, the major need of modern gladiolus is increased disease resistance to *Fusarium, Curvularia* and *Botrytis* fungi, and virus diseases. It is hoped that the untried species, such as *G. hookerii*, can provide genes for resistance to one or more of these organisms.

Test Gardens

Test gardens are operated by the North American Gladiolus Council to rate seedlings for exhibition use before introduction and by the University of Florida to evaluate them for cut flower use. Information obtained from these trials can aid breeders in determining if a new seedling is good enough to name and introduce. All new cultivars should be registered with the North American Gladiolus Council at the time of their release. A successful gladiolus seedling can be of great professional as well as monetary value to the breeder.

For Further Readings

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A group of gladidanthera hybrids *(Gladiolus* x *Acidanthera murielae)* is shown at left, and, right, the *Acidanthera* parent.

Gladidanthera hybrids—a new field for home garden hybridizers

HYBRIDS FROM GLADIOLUS AND ACIDANTHERA

Leo A. Dionne

THE NAME gladidanthera has been coined for the hybrids produced by crossing garden *Gladiolus,* whose flowers are unscented, with the related, strongly fragrant *Acidanthera murielae.* For home gardeners interested in breeding these fascinating new plants, the following information is based on a study presently underway at the University of New Brunswick, Fredericton, N. B., Canada.

The cross is only successful with *Gladiolus* as the female parent, and *Gladiolus* cultivars vary enormously in the ease with which they accept *Acidanthera* pollen. Some will not set seed at all to the foreign pollen while others will produce large quantities of viable seeds.

The first generation hybrids have the general appearance of *Gladiolus* in all the colors we associate with this popular cut flower. The hybrids rarely open more than two or three flowers at one time. However, occasional superior clones will open four or even five flowers.

Most of the hybrids are fragrant but quite a number are only faintly scented. Very few have as penetrating an odor as the *Acidanthera* parent and none have the typical *Acidanthera* perfume, although most have a light and pleasant scent. The perfume of the hybrids appears to have two components; one is suggestive of *Eucalyptus,* the other of an odor common in *Dianthus.* In some of the hybrids one or the other of the perfumes predominates, others have a blend of the two, and some have little of either. Unfortunately some people are "smell blind" to one or the other or both components, and a few cannot even detect perfume in *Acidanthera.*

Few of the hybrids are as early flowering as *Gladiolus.* Most are intermediate, blooming in about three months, and some as late as or later than *Acidanthera.*

The first generation gladidantheras are fertile and for breeding appear to be best used as female parents. New Zealand work has indicated that the most productive procedure for the second generation is to back-cross the F_1 to *Acidanthera.* This and other approaches are now being explored at the University of New Brunswick. ☘

A scientific approach to

IRIS BREEDING

Katherine H. Heinig

In iris, perhaps more extensively than in any other ornamental plants with the possible exception of orchids, the development of new cultivars has resulted from hybridization between species. With few exceptions the cultivars grown today are first or advance generation hybrids of different species. Many iris species hybridize readily and natural hybrids are often found where species grow in close proximity. Several well-known species, such as *I. pumila, chamaeiris* and *versicolor,* are in fact of hybrid origin. Although crosses involving iris species belonging to the same or different subdivisions of the genus often produce fertile or partially fertile hybrids, genetic and chromosomal dissimilarities may serve as barriers to crossability. Since hybrids are usually obtained more readily from closely related species, a knowledge of botanical relationships is helpful in iris breeding.

Natural Relationships of Species

The genus *Iris* is composed of somewhat more than 200 species of which more than half are grown in gardens and used in hybridizing. Botanically these are grouped into four subgenera. The subgenus Xiphium, which includes the Reticulatas as well as the Spanish, English and hybrid Dutch iris, and the subgenus Scorpiris or Juno iris are bulbous. Their native habitat is the Mediterranean basin, southeastern Europe and Iran. The subgenus Nepalensis consists of a single species, *I. decora,* occasionally grown for its lovely evanescent flowers. The more common garden iris are rhizomatous and comprise the large subgenus Iris. This last subgenus includes the bearded Eupogon, Oncocyclus and Regelia iris and the beardless Spuria, Japanese, Siberian, Louisiana and Pacific Coast iris as well as the crested iris or Evansias. In general the beardless species have a circumboreal distribution in temperate latitudes.

To utilize iris species and varieties most effectively in breeding it is necessary to know their chromosome numbers. With rare exceptions all the individuals of a species have the same number and kind of chromosomes. Although related species may have the same chromosome complement or karyotype they often differ in chromosome number, in various structural features of the chromosomes, or in the kinds and arrangements of their genes. Among bearded iris, the basic chromosome number in Eupogons is 8 or 12, Regelias 11, and in Oncocyclus 10, and some of their chromosomes differ in form also.

Polyploid species with chromosome numbers in multiples of the base number are to be found in various sections of the genus and several have proved to be extremely valuable in breeding.

Species of Promise

Improvements in garden iris will continue to be achieved through intensive breeding of existing varieties, and there is increasing evidence that new types will be produced through the imaginative use of various species hitherto not widely used in hybridizing.

Although all of the Eupogon dwarf species may be intercrossed and crossed with diploid and tetraploid tall bearded species to produce various sorts of dwarf and intermediate hybrids, a few are particularly noteworthy. These are the 32-chromosome tetraploid species, *I. pumila,* the 48-chromosome tetraploids *I. balkana* and *I. aphylla,* and the 24-chromosome diploid species *I. mellita, reichenbachii (bosniaca)* and *rubromarginata.*

The species *I. pumila* has proven especially valuable as a parent. Many attractive miniature dwarf varieties have orignated from this species. Crosses of *I. pumila* with 48-chromosome tall bearded cultivars yield fertile hybrids resembling the 40-chromosome dwarf, *I. chamaeiris*. These hybrids give promise of serving as a vehicle for the transmission of desirable tall bearded traits to dwarf iris.

Breeding has indicated that new gene combinations resulting in distinctive new varieties may be obtained from intercrossing existing tetraploid varieties and various untried diploid species.

Most of the breeding with beardless types is restricted to Spuria and Louisiana iris. Spuria varieties of excellent garden value have originated from crosses of *I. spuria, ochroleuca, monnieri* and *aurea*. The improvement of Louisiana iris has involved the use of three closely related species, *I. fulva, brevicaulis* and *giganticaerulea*, and their naturally occurring hybrids.

Several attractive hybrids have been achieved from crosses of the Pacific Coast species *I. innominata, douglasiana* and *munzii*, and from crosses of these species with Siberian iris. The latter hybrids are, however, highly sterile. Most of the garden varieties of Siberian iris are hybrids of the 28-chromosome species *I. siberica* and *I. sanguinea (I. orientalis)*, although interesting varieties might also be achieved through the interbreeding of the 40-chromosome species *I. foresttii, clarkei, delavayi, chrysographes, wilsonii* and *bulleyana*.

New iris varieties may be achieved through interspecific hybridization and by outcrossing of existing varieties to basic species. However, though genetic variability may be introduced through hybridization and some first generation hybrids may have distinct garden value, further breeding is usually necessary to isolate and perfect desirable combinations of traits. This may be accomplished through line breeding of selected hybrid progeny by means of self-pollination and sib crosses (crosses of sister seedlings) with occasional backcrosses to one or the other parent.

In general, interspecific hybrids may best be achieved between closely related diploid species of the same chromosome number or between tetraploid species. Such hybrids would be expected to be fertile and amenable to improvement through further breeding and selection. Hybrids between distantly related species or between species with different chromosome number can often be produced but since at best they are usually only partially fertile they are of limited value in breeding.

It is not difficult to cross iris for in general the flowers are large and the stamens and stigmatic surfaces easily accessible.

The structure of the iris flower is such that cross-pollination is the rule and self contamination is rare except in Spuria and Siberian iris. Bees are the chief pollinating agents and if they are active some precaution against contamination is necessary. Care should be taken to use only freshly opened blooms and after pollination the falls should be broken at the base to prevent pollen laden insects landing near the receptive surface of the stigma. In Spuria and Siberian iris it is also advisable to remove the stamens before the flower opens.

The stamen is removed with tweezers and the pollen applied to the upper surface of each of the three stigmas as shown in the accompanying illustrations. If pollen is applied with a camel's hair brush, as sometimes is necessary when stored pollen is used, the brush should be sterilized by dipping in a vial of 50% ethyl alcohol between each different cross. As soon as the flower is pollinated it should be tagged and a full record of the cross made in a notebook.

Seeds of bearded iris are harvested when they turn brown and the pods split open, usually about 60 days after pollination. At this stage the seed should be removed from the pods and air dried at room temperature. Planted in late fall they will normally germinate the following spring. Somewhat better germination has been reported in Louisiana iris if the seeds are harvested and planted while still green.

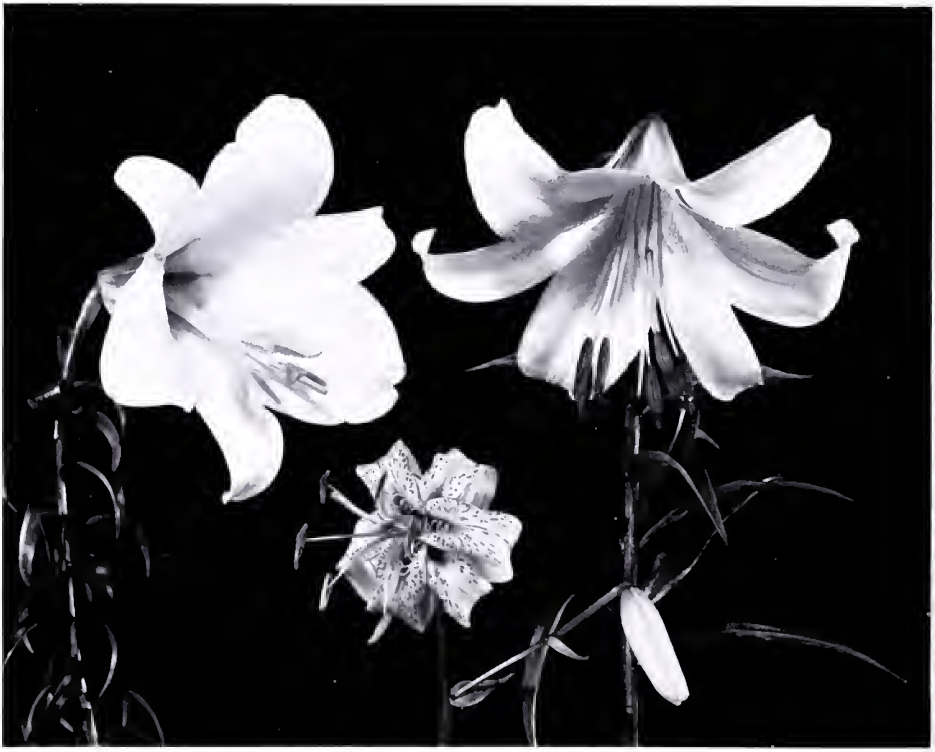
The lily, as a result of breeding, is beginning to achieve its true place in the sun

LILIES–A LOVELY CHALLENGE FOR THE HYBRIDIZER

Edward A. and Judith F. McRae

The lily possesses a greater diversity of forms and seasons of effectiveness than almost any other garden plant. The last four decades have seen it begin, through breeding, to achieve its true place in the sun. A host of lovely, dependable lilies are already growing profusely, and finer ones are appearing annually. The new bright reds, yellows, pinks and golds have done much to dispel the image given the genus *Lilium* by the familiar tiger and Easter lilies.

The lily offers unlimited opportunities for amateur and professional plant breeders; a love of plants and a thorough knowledge of his material assure the breeder a great measure of fulfillment and joy. He must seek every scrap of information in his endeavor, which will not only trigger new ideas, but also help to avoid unnecessary repetition, so he is able to build on the foundation already begun. The clearer colors, vigor, disease resistance and virus tolerance are essential



Lilium leucanthum var. *centifolium* (left) crossed with *L. henryi* (center) produce Aurelian Hybrids (right) which are intermediate in form and color between the parents.

qualities in any hybrid lily for any climate. After achieving these, the breeder may turn to plant structure and form, flower form, fragrance, climate adaptability and other characteristics. The setting of clearly defined goals and the maintenance of good records are advised, for little will be accomplished by haphazard pollinations. The beginner should start on a small scale and increase his work as knowledge, experience and facilities permit.

A knowledge of elementary genetics is helpful but not essential in amateur lily breeding, for plant breeding is as much an art as a science. A breeder's strength lies in a love for what he is doing and his ability to recognize a worthwhile lily at a glance. He must be a good plantsman and sound in practical skills, able to make intelligent and practical observations, and aware of what modifications are beneficial. The amateur breeder has the opportunity, moreover, of pursuing his own vision of beauty and utility, unfettered by a need for mass commercial appeal.

A knowledge of the botanical and geographical relationships of lilies is essential; the more closely related the species, the more readily they cross. Comber's classification, found in most lily books and in the 1949 *Royal Horticultural Society Lily Year Book,* groups lilies according to their natural affinities. Experienced breeders assert that lilies are self-sterile; that is, they will not set seed with their own pollen or that of another plant of the same clone. There are rare cases in which apomixis (seed set from pollination without true fertilization) is suspected, but by far the majority of claims of "selfing" are simply the result of contaminated pollinations.

The large flowers of lilies are ideal for pollination. Pollen should be collected early the morning the flower opens. Dried pollen stores well—for a few days refrigerated or longer if frozen. Anthers of the seed parent are removed before the flower opens and pollen of the male parent is brushed on with a pipe cleaner. The stigma is immediately covered with an aluminum foil cap, easily made by wrapping a small strip of foil round a pencil and twisting the end; and the cross is labelled. Hands must not be contaminated with stray pollen and should be wiped in alcohol between crosses. Lilies flowering nearby should have their pollen removed. The authenticity of a cross can never be assumed if pollinations are not fully protected from unintentional contamination.

The developing pods (fruits) may be sprayed with Benlate, to prevent botrytis blight, if moist weather threatens. The pods of late-flowering lilies should be taken indoors to ripen if frost is likely. It is wise to stake lilies bearing pods; too many pods on one plant may weaken it severely, so it is better to allow only a few to set. The pods are gathered as soon as they begin to split open; they are dried, shelled, and the seeds completely dried before storage in the refrigerator or freezer until spring planting.

The breeder must be thoroughly familiar with cultural procedures. Seeds should be sown in clean or sterilized soil. Some lily seeds germinate immediately (epigeal germination), whereas others first produce a small bulb and require a cold period before producing above-ground growth (hypogeal germination). The breeder must know to which group his hybrids belong.

The seedlings must not be too crowded, and they should grow to maturity before final evaluations are made. Many a fine lily has been discarded prematurely. The forms chosen can then be named or coded, and propagated vegetatively by bulblets, bulbils or scales. It is wise to distribute a really fine hybrid among friends, both to share its beauty and to guarantee its survival.

Related Groups

Most lily hybrids have been produced within the following groups, which represent natural genetic affinities:

ASIATIC HYBRIDS, whose backgrounds include *Lilium dauricum, L. maculatum, L. tigrinum, L. davidii* and *L. cernuum.* A wealth of beauty has been incorporated into this group, producing lilies of many uses, in all shades and combinations of yellow, orange, red, pink and white. The flowers may be upright, side-facing, or nodding, borne by superb showy garden plants, miniature pot plants, or the strong stems of cut flowers. Most of these lilies introduced are highly persistent in all climates. The early flowering characteristic of *L. dauricum*, the vigor of *L. tigrinum*, the virus tolerance of *L. davidii*, and the lovely pinks and whites of *L. cernuum* are just part of the gene pool represented. These lilies cross readily, eliminating the frustrations of markedly incompatible lines.

MARTAGON-HANSONII-TSINGTAUENSE HYBRIDS, characterized by dramatic whorled leaves and many nodding Turk's-cap flowers in all shades of white, yellow and burgundy. The early *L. martagon-L.hansonii* hybrids, known as the Backhouse Hybrids, are typically lovely, rarely become infected with virus, and persist for many years when properly established. They grow best in cooler climates and are seldom a success in warmer areas. The combined colors of many first generation crosses, such as *L. martagon* x *L. hansonii*, will separate in the second generation to produce clearer shades of pink and yellow. The recent introduction of the upright *L. tsingtauense* opens up new possibilities, including forms that will have upright flowers.

WESTERN AMERICAN HYBRIDS, whose backgrounds include *L. pardalinum, L. humboldtii, L. parryi, L. kelloggii* and *L. bolanderi*. The famous Bellingham Hybrids were the result of crossing two or more of these West Coast species. Many fine characteristics await the breeder here, including lovely colors and subtle fragrances. A number of species intercross readily. A recent second generation cross between *L. kelloggii* and *L. pardalinum* produced attractive bright red, pink and soft yellow clones.

TRUMPET AND AURELIAN HYBRIDS, derived from the trumpet-flowered species *L. sargentiae, L. leucanthum, L. regale* and *L. sulphureum*, and the reflexed-flowered species *L. henryi*. There are now true-breeding F_1 trumpet strains. After generations of test crosses and selection, parents have been derived which produce progeny all with the desired traits and very uniform in habit. The seedlings inherit the disease resistance, vigor and virus tolerance of the parents, present with the fine qualities of youth. Seed-produced strains are, moreover, initially free from viruses, which are not seed-transmitted. The trumpet lilies are available in lemon yellow, deep yellow, white, copper, apricot and pink.

The Aurelian lilies result from crossing trumpet species with *L. henryi*, which has golden-orange reflexed flowers. The hybrids are extremely vigorous, with flowers intermediate in form between their parents. Many fine clones and strains are available, and recent breeding has concentrated on low-growing forms and lilies possessing greater virus tolerance.

ORIENTAL HYBRIDS, derived from such species as *L. auratum, L. speciosum, L. japonicum* and *L. rubellum*. These are the true aristocrats of lilydom, and enthusiasts the world over are avidly pursuing them for their beauty. The first successful cross within this group was *L. speciosum* x *L. auratum*. The wide variations found in both species have produced succeeding generations of hybrids of varied form, in white, pink, crimson and gold-striped combinations, with an endless array of spotting patterns. There are many highly persistent, disease-resistant clones which should form the foundation of any breeding program. The lovely pinks now available can be traced to *L. japonicum* and *L. rubellum;* the latter also transmits short stature and early flowering. A diminutive form of *L. auratum* found in New Zealand has resulted in miniatures in all colors. Recent breeding has incorporated the lovely Japanese species *L. nobilissimum* and *L. alexandrae*.

Embryo Technique

At times, viable embryos within the developing seeds die before the seed ripens, due to deterioration of the endosperm. It is possible to secure hybrids from such crosses by removing the living embryo and growing it on an artificial medium, a technique within the scope of the amateur breeder. An excellent medium for lilies is obtained by heating together 3.3 g (¾ t) Miracle-Gro fertilizer, 40.0 g (3 T) sugar, 16.0 g (8 t) agar, 2 L (8⅞ c) distilled water, until ingredients are dissolved. Four-ounce bottles or 20mm x 150mm test tubes are half filled and then stoppered with cotton wads; they are sterilized in a pressure cooker at 15 lbs. pressure for 20 minutes. Green pods can be dissected on a surface just wiped in alcohol and covered (to prevent contamination by breathing) with a glass panel; knives or needles should be dipped in alcohol and passed through a flame for sterility.

The embryo is quickly cut out and popped into a bottle, which is uncapped only long enough to permit the transfer. At all times avoid touching the embryo with your hands. If there are no drafts nor dirty hands, there is usually only occasional contamination of the bottles. These are now placed where they receive indirect light (direct rays may be focused by the glass to burn embryos), and will turn green and grow within two weeks. When they have three or four leaves, they can be transplanted, after all the gel is removed, into soil and treated as any seedling.

A number of wide crosses, such as *L. candidum* x *L. monadelphum* and *L. speciosum punctatum* x *L. henryi*, have captured the imagination of many amateur breeders. These are interesting to one with limitless patience, but they must not be overemphasized in one's breeding. Far more awaits those working in more fertile lines, and many species are beautiful and valuable enough in themselves to warrant intelligent work. ⁂

Marjorie J. Dietz

Modern lily hybrids have proved to be far more dependable garden subjects than the majority of species. Lily hybrids are shown here flowering in company of perennial baby's breath.

"The woods, plains, mountains and deserts of North America are an immense reservoir of exciting plant material waiting the hand of the plant breeder who has the vision and desire to explore the unknown. . ."

TAMING THE WILD ONES

Glenn Viehmeyer

You, the amateur, do not need to have training in genetics and plant breeding. The first articles in this Handbook tell you the basics you need to start with. Your tools, which are an inquiring mind, a knowledge of sex and an awareness of death, are all you need: A mind that can envision possibilities, an eye that can detect variation, sex that you can manipulate to produce new forms, and utter ruthlessness to destroy all but those individuals that show progress toward the goals you have envisioned. From this viewpoint let us look at a few native species and try to see their potentials.

Prairie Coneflower *(Ratidiba columnaris)*

This native composite, with its elongated cone, frilled with drooping rays that resemble a ballerina's tutu, is found from the prairies of Canada to the Gulf of Mexico. In the garden it blooms from mid-June until frost. It is a short-lived perennial that starts to flower the first year. Over most of its range, yellow is the predominant color but occasional red forms occur. In a few populations red may dominate.

Prairie coneflower responds to the breeder's hand. In five generations the author has quadrupled the size of the flower heads and the number of rays, and has produced a wide array of variegated flowers flushed and blotched with red. Individual flower heads are borne singly on fairly long, wiry stems and last well as cut flowers.

Prairie coneflower is easy to grow from seed sown at any time of the year. Seed from the season's first blooms may be sown immediately to produce strong plants by autumn. Seed sown in flats in March, with good culture, will produce blooming plants by late June. Plants also start readily from cuttings.

Our Lord's Candles, Soapweed, Spanish Bayonet, etc. (*Yucca* species)

These members of the lily family light a thousand hills with their tall flower stems in late spring and early summer. Broad-leaved evergreens with strap-like, sharp-pointed leaves, they have claimed a place in western art. However, except for the forms of *Yucca filamentosa* and *Y. flaccida* offered by many nurseries, they are ignored by gardeners, who might well make them an important part of the landscape plan. These plants present new dimensions in texture and form that add much to the garden.

The most widely spread species appears to be Y. *glauca,* which ranges southward from the Cypress Hills of Saskatchewan to the northern half of Texas in a belt nearly 1,000 miles long and up to 500 miles wide. As might be expected of a plant with such a wide distribution, there is much variation. In the Pryor Mountains of northern Wyoming and southern Montana there is a very glaucous, silvery white-flowered form. In the sandhills of Nebraska the strict spikes are 5 or 6 feet tall, and the flowers may be greenish white or may have mahogany sepals. In South Dakota Claude Barr of Smithwick claims a "brilliant pink" form.

In Colorado and Utah *Y. harrimaniae* makes neat little clumps of stiff, dagger-like leaves that surround the short raceme of flowers. Farther south *Y. baccata* lifts its huge flowers and fruits above coarse, dark green foliage, while in the deserts of the Southwest the Joshua tree *(Yucca* *revifolia)* lifts its heads of daggers to 0 feet and produces spikes of white bloom.

Most interesting is the fact that in reas where species overlap swarms of hybrids may occur. Some of these are quite ornamental. More important, hybridity in natural populations indicates that the breeder might find the yuccas a good genus for interspecific hybridization.

Sundrops *(Oenothera serrulata)*

This sub-shrub is readily tamed. The ittle, round-topped, multi-branched plants are excellent for border or rock garden, where with good culture they will display a wealth of gold from June until frost.

The flowers are typical of the evening-primrose, with the usual four petals and the long style of the genus. Unlike most of its kin the flowers do not fold up by mid-morning but last all day except in the very hottest weather. In most populations individual blooms are ¾-one inch across, but in mid-May of last year the author discovered a population in the panhandle of Oklahoma with blooms 2 inches across. Needless to say, plants were collected and are being established in my garden at North Platte, Nebraska where they will be increased for distribution to interested horticulturists.

The flower texture of this *Oenothera* is interesting and in certain plants the petals have a crinkled crepe-like texture. Plants are easily transplanted even when in full bloom. Seed germinates readily if autumn-sown and a carpet of seedlings usually appears around the old plant in the spring. It will also start from cuttings without great difficulty.

Sundrops merit a place in both border and rock garden. The neat little round-topped shrubby plants with gleaming gold-coin flowers are eye stoppers. These are ornamentals that should have the attention of both the amateur and professional breeder.

Hummingbird-Trumpet, Firechalis *(Zauschneria garrettii)*

Spectacular is the only word for this member of the evening-primrose family. Its long-throated, blazing scarlet trumpets can hide the leaves in a well-grown specimen plant.

Dwarf and normal types of *Yucca harrimaniae,* a yucca species found in Colorado and Utah.

As you travel the backroads or tramp through the canyons of the Colorado Plateau, you may stumble into a clump of blazing bloom that could be mistaken for Indian-paintbrush but a closer look will show the typical four-parted flower of the evening-primrose tribe. This plant should be tamed for our gardens because it is an excellent ornamental even as a wildling. Under the hand of the plant breeder, firechalis should develop into one of the better new plants.

Little can be said about culture and propagation. Old clumps can be divided, and I think that seed sown as soon as ripe on the surface of the soil might be successful. Perhaps autumn-sown seed will germinate the following spring as is the case with the closely related sundrop described above.

Beardstongue, Penstemon *(Penstemon* sp.)

The genus *Penstemon,* which has more than 300 species and many geographic races, offers endless opportunity to the would-be plant breeder. There are plants for about every garden use, ranging from the inch-tall mats of *Penstemon caespitosus desertipictii* to 6-foot-tall giant forms of *P. havardii* and *P. murrayanus.*

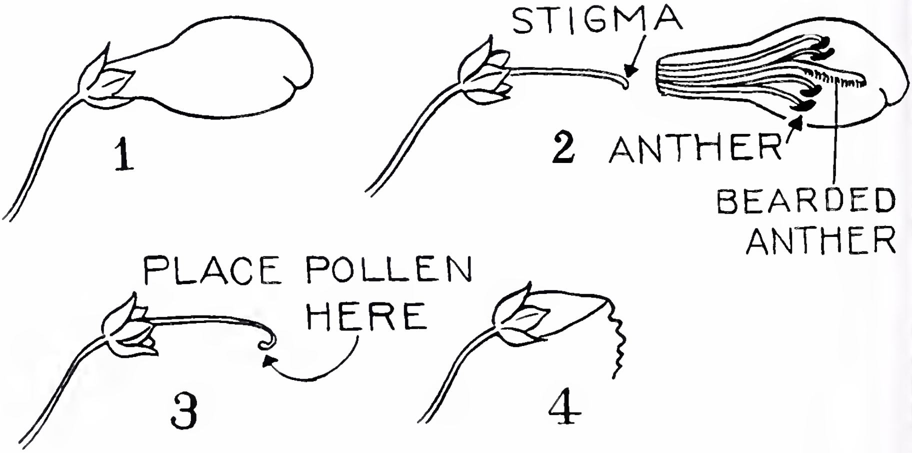
In the southwestern deserts, *P. antirrhinoides microphyllus* becomes a woody shrub with stems 2 or more inches in diameter. Sprawling over banks and bushes *P. cordifolius* makes a vining plant.

The penstemon genus has its own special plant society, The American Penstemon Society, which has for the past quarter-century devoted itself toward taming the penstemon and adapting it to garden use. (For the address, see p. 6.) Experimenting with penstemon is an exciting adventure for those who like to explore new frontiers. Most species of penstemon are specialists adapted to particular econiches and unhappy in any other. The eastern species are the easiest garden subjects. Unfortunately they are far less showy than ones native to the high plains, mountains and deserts of North America. These westerners do not thrive in the unfamiliar habitat of gardens, where high fertility and ample moisture make them easy victims of disease and insects. As a result many species, even though perennial in nature, behave as biennials or short-lived perennials and are frequently monocarpic, fruiting once and dying.

The answer to this problem lies in interspecific hybridization, which broadens the genetic base of the hybrid populations and offers greater opportunities for selection of individuals better adapted to the garden and having greater disease resistance.

As an example, crossing the tall, red-flowered *P. barbatus* of the southern Colorado Plateau and the southern Rocky Mountains with the blue-flowered species from the northern areas has resulted in a hybrid complex that fits the garden environment better than either parental type.

From such hybrid populations it has been possible to select clones more disease-resistant, longer-lived, and with better ornamental value than any of the 30 or 40 species that make up the hybrid complex. (Those who want more information about breeding and using penstemon in the garden can obtain free of charge the bulletin *Penstemon in Your Garden* by writing to the University of Nebraska North Platte Station, North Platte, Nebraska 69101.)



Author's sketch

Diagram of pollination of penstemon flower. 1. Diagram of a penstemon bud, ready for emasculation. 2. Emasculation of flower, i.e., petals with stamens pulled away, leaving the stigma exposed. Penstemon has four pollen-bearing stamens and one that is sterile and bearded. The latter gives rise to the popular name of this flower—"beard-tongue." 3. Emasculated flower with pistil ready to receive pollen. 4. Two weeks after pollination; the seed capsule (botanically the fruit) is forming.

Rock garden plants represent a field full of promise for the amateur breeder

SAXIFRAGES AND OTHER ROCK GARDEN PLANTS

H. Lincoln Foster

ROCK GARDENERS tend to be a cultish clan, ridden by exclusive inhibitions. Very few of them will admit an annual plant into the garden, and for most of them hybrids are anathema. Wild species from the alpine reaches of the most remote mountains are what they seek and prize. To grow the untameable *Eritrichium nanum* or *Jankaea heldrichii* is the mark and seal of the alpine gardener.

It must be admitted that some have fallen from these rarified heights and, seduced by the beauty of certain genera among the mountain plants, have indulged in a bit of hybridizing, or have succumbed to the charm of a hybrid campanula or dianthus that has appeared by chance in the garden. Some of these chance hybrids are named and perpetuated by vegetative propagation. Except in a small number of rock garden genera, however, little intentional breeding has been attempted. Yet, despite the continuing bias in favor of wild species, considerable strides have been made in breeding saxifrages, lewisias, primulas and a few others in the direction of improved flower color and size and in general adaptability.

The genus *Saxifraga* is a large one, large enough indeed, to be divided by taxonomists into fifteen sections, comprising in all about 300 species. Three of these sections furnish species and hybrids that have long been treasured in the rock garden. The "mossy saxifrages" of the Dactyloides section have given rise to many named hybrids and the same is true among the "encrusted" sorts in the Euaizoonia section. Hybrids among all twelve species in this section have given rise to many named forms, especially because each species is naturally variable and they are readily interfertile. In fact, so promiscuous are they in the garden that it is difficult to grow from seed a true species except where the seed is collected in the wild. All are handsome for foliage effect with large or small rosettes of lime-edged leaves and most with rapidly spreading offset rosettes. The smallish flowers of white, yellow, or rose color are arranged in branching panicles during the summer.

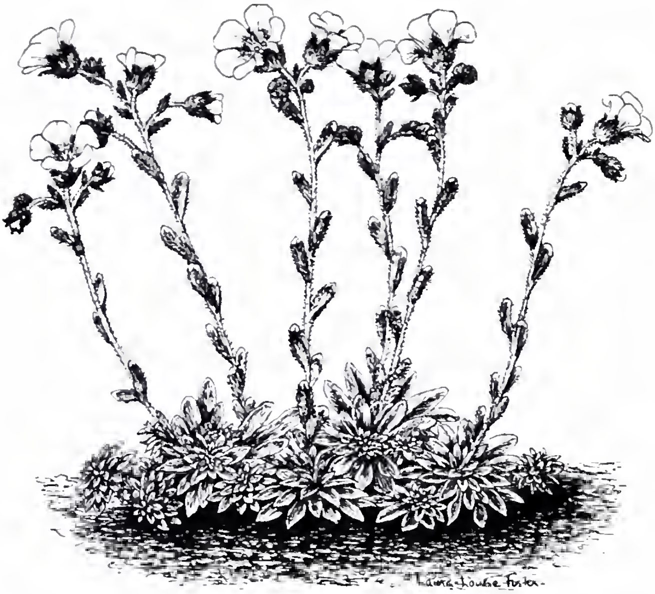
Kabschia Saxifrages

It is among the Kabschia section, however, that the true gems in *Saxifraga* appear and it is from the twenty or so species of the section in cultivation that a very sizeable assortment of named hybrids has been created. The section itself may be divided into two sub-sections with rather distinct characteristics, but the readily made hybrids among them tend to swamp out the distinctions.

The true Kabschias form dense cushions of small pointed or blunt leaves. The early spring flowers of ample size on short stems may be solitary or several

Laura Louise Foster

A Kabschia saxifrage, representative of a section of the genus *Saxifraga*.



Drawings by Laura Louise Foster from Rock Gardening

Saxifrages of the sub-section Engleria. They readily hybridize with the Kabschia species.

on short branches. Colors are most commonly white, but are also yellow and in one species in cultivation, lilac pink. The species of the Engleria sub-section have rather larger rosettes of flattish leaves handsomely margined with lime dots. The smallish flowers of usually red or purple top the croisier-form stems, brilliant with colored calyces and colored stem leaves. Blooming as they do along with the true Kabschias, many hybrids have been made between species of the two sub-sections, producing plants of intermediate character. Features from the Englerias, however, are generally obvious and from this group the red and purple color has been added to the larger flowers of the true Kabschias.

Between the two world wars there was a great burst of hybridizing among the Kabschia saxifrages in England and some in Germany. The names Boyd and Prichard in England and Suendermann in Germany are associated with some of the best introductions of the era, but every rock garden nursery named and proclaimed its own productions. There were probably as many as 200 named cultivars. The show benches were resplendent with 12-inch pans overflowing with rosettes smothered with flowers. Much of this material was lost during the Second World War and the hybrids have rather gone out of fashion among English alpine gardeners, who have turned their attention to recent introductions from the Middle East.

Recently, however, in America and Czechoslovakia there has been a sudden surge of interest in the species and hybrids. Many of the older cultivars have been rediscovered and propagated and a whole new set of hybrids has been created and named. There have been no startling color breaks as yet (no blues, for instance), but there have been subtle differences in shade and size of blossom and foliage variation. Because many of the hybrids are fully fertile, it is still possible to make new combinations. One important direction in which the hybridist should be encouraged to work is toward greater adaptability to lowland continental climate. Saxifrages, which are true alpines, suffer badly during hot, muggy weather in the summer. Breeding for olerance of these conditions would be most rewarding. The results of breeding are fairly quickly apparent as most saxirages will bloom the third year from eed and all propagate readily from cutings.

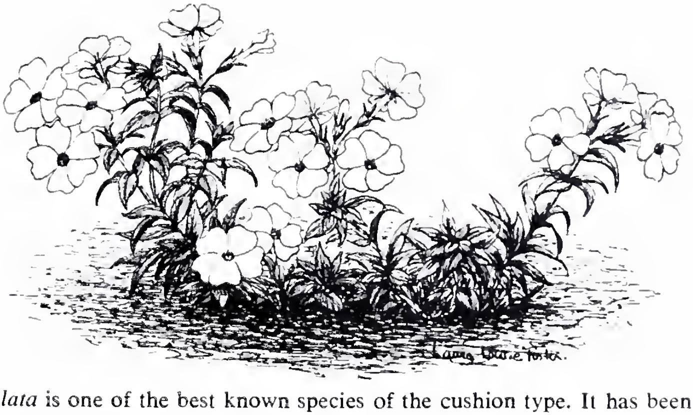
Lewisia

Although interest in Kabschia saxifrage growing and breeding may have languished among British rock gardeners, he same cannot be said of the American genus *Lewisia*. The English and Scots have taken these plants to heart and have leveloped some remarkably fine garden orms, mostly in the *Lewisia cotyledon* complex. Formerly divided into as many as six separate species, *L. cotyledon* is now considered a variable single species. The fleshy tongue-like evergreen leaves hat lie out and overlap to form a large dense rosette may be smooth or toothed or wavy on the margins. The ample flowers arranged in a tall branching inflorescence may be white, white with pink stripes, orange with red stripes, solid pink, or magenta. By selection and breedng among these, size of flowers, color of lowers, shape of leaves, and garden adaptability have all been affected, and the current forms in England are referred to as Cotyledon Hybrids though they are more properly selections within the variable species. To be sure, there have been some true hybrids produced by crossing *L. cotyledon* with a few of the other sixteen species in the genus, but the most beautiful species, *L. tweedyi* (of unique chromosome number), has resisted such treatment. The *L. cotyledon* strains that have been bred in England and Scotland, and more recently in Czechoslovakia, have been of particular value because they have proved to be far more adaptable to garden culture than plants from the mountains of Oregon and northern California where they make their homes.

Phlox

Another genus of American plants that has been enriched by interbreeding is the genus *Phlox*. For the rock garden some hybrids have been made among the creeping species. The common eastern *Phlox subulata* has been improved by crossing with *P. stolonifera* and *P. bifida,* and sparingly with the splendid needle-leaved species of the western highlands. One very recent crossing of eastern *P. stolonifera* with the beautiful but difficult *P. adsurgens* of the Oregon mountains shows considerable promise.

Once the bias among rock gardeners in favor of pure species from the wild is modified by the decrease in number of new species being introduced, the natural desire for novelty will doubtless give impetus to more and more breeding of hybrids by growers of alpine and rock garden plants. It is a field full of promise. ⁂



Phlox subulata is one of the best known species of the cushion type. It has been successfully crossed with *P. stolonifera* and other native American species.

Goals in camellia breeding: greater hardiness, forms suitable for house plants and hanging baskets

BREEDING NEW CAMELLIAS

W. L. Ackerman

Camellias in their native habitat, the Orient, are grown for their flowers, for the oil of the seeds of certain species, and for tea leaves from *Camellia (Thea) sinensis*. The genus *Camellia* is in fact a member of the tea family (Theaceae). In both Europe and the United States we know camellias primarily as ornamental shrubs and trees with glossy evergreen leaves and large attractive flowers.

The most popular camellias in the United States are the spring-flowering *C. japonica* and the autumn-flowering *C. sasanqua*. The many cultivars of these two species are grown outdoors in the southern and Pacific Coast states and, to an extent, in greenhouses in the North. Less frequently cultivated species are *C. reticulata, C. hiemalis, C. saluenensis* and *C. vernalis*.

Too Much to Chance?

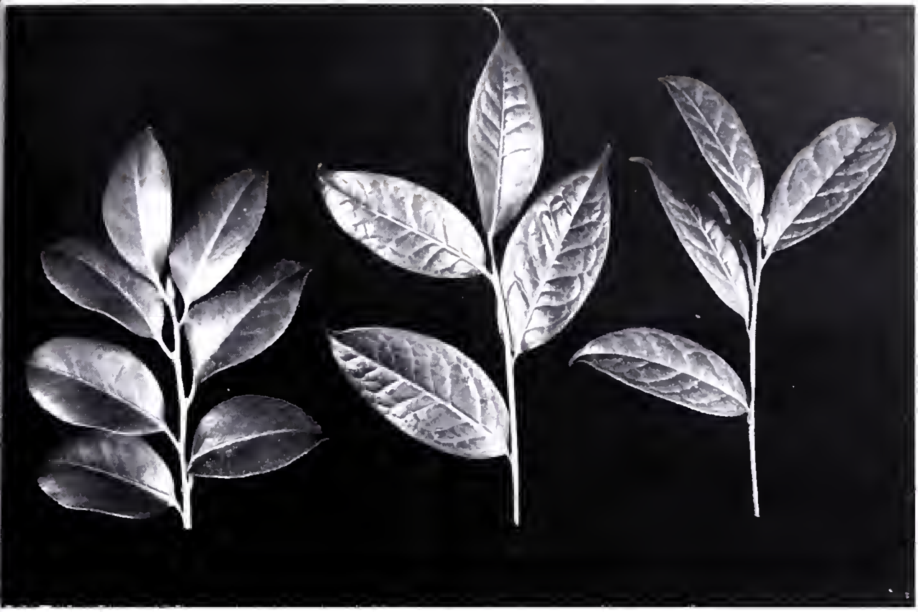
The thousands of camellia cultivars we have today have resulted largely from chance seedlings and sports of existing cultivars. Relatively few have been from controlled crosses. A review of new cultivars listed by the American Camellia Society during a nine-year period (1962-1970) shows that, among 582 camellias registered, 493 were chance seedlings, 50 were sports (spontaneous mutations), 19 were intraspecific crosses of known parentage, and 20 were interspecific hybrids. Until the past decade, little attention was given to interspecific and intergeneric hybridization.

It has been said that much of the useful intraspecific genetic variation has been exploited, especially in *C. japonica*. Without the introduction of new germ plasm into camellia breeding, the potential for new forms becomes increasingly restricted. Thus, it would seem that, although less than four per cent of the cultivars introduced from 1962 throug 1970 were interspecific hybrids, it is i this area that the greatest future advance will be made.

The variations in vegetative and flor characteristics in *C. japonica* and *C* *sasanqua* are limited. Flower color is confined to white through red, in solid color and variegated patterns; there is no yello or blue. Most cultivars have the habit o retaining old withered flowers. If on discounts the unpleasant musky odor o many *C. sasanqua* forms and the fe faintly scented cultivars of *C. japonic* floral fragrance is lacking. Efforts to intensify the faint fragrance found in *C* *japonica* through intraspecific crosses hav been disappointing. The natural flowerin season for cultivated species is limite to the spring and autumn. There ar no summer-flowering cultivars. Improve cold hardiness would be desirable becaus outdoor culture, except in very protecte areas, is largely confined in the easter United States to Maryland southward.

Use of Other Species

The almost exclusive dependence on *C* *japonica* and *C. sasanqua* is unwarrante for there are about 80 other *Camelli* species. Diversity within the genus an number of indigenous species indicate th center of origin of *Camellia* to be in th region of southern China and North Vietnam. Many species that were described b early plant taxonomists were never successfully introduced and are not no available to plant breeders. However, a least 32 species are in cultivation in th free world. The U. S. Plant Introductio Station, Glenn Dale, Maryland has 28 o these in its collection. There is a wid variation in floral and vegetative characters among these, reflecting a great diversity between species. The less-known spe



ig. 1 Leaf patterns of camellia parents and hybrids: **left,** *Camellia japonica,* seed parent; **enter,** hybrid; **right,** *C. granthamiana,* pollen parent.

ies have many desirable characters not ound in the cultivated forms. None have lue flowers, although purple- and yellowowered species do exist. It is a challenge the plant breeder to use the germ plasm vailable and develop new interspecific aces of camellias.

Interspecific and Intergeneric Hybridization

lthough interspecific and intergeneric rosses are frequently difficult and sometimes unsuccessful, embryo-culture techiques have done much to expand the ossibilities of germinating seeds of low iability. Guidelines have been established egarding species compatibility relationhips within *Camellia.* A program of hyridization was initiated in 1960 at the lenn Dale Plant Introduction Station. ver a 13-year period, a total of some 0,000 controlled pollinations were made, nvolving 25 species and representing 243 nterspecific combinations, including reiprocal crosses. A total of 1,368 hybrid lants from 124 different combinations vas obtained. These data can be useful to lant breeders in illustrating combinations that can be expected to produce hybrids.

Attempts were also made at Glenn Dale to cross several *Camellia* species with species of closely related genera, namely *Tutcheria spectabilis, T. virgata, Franklinia alatamaha* and *Stewartia ovata.* Eleven plants judged to be valid hybrids were obtained from three intergeneric combinations. These were *Tutcheria virgata* x *C. granthamania, T. virgata* x *C. miyagii,* and *C. pitardii* var. *pitardii* x *T. spectabilis.*

Vegetative Characteristics

Hybrid validity can be determined by a comparison of the hybrid's vegetative characters with those of its parents. This evidence can later be supported by comparisons of flower characters, pollen abortion, and chromosome counts.

Species possessing dominant characters can be extremely useful to the plant breeder when those species are used as pollen parents. Similarities between progeny and the pollen parent help confirm hybridity. This may be illustrated by the dominance of hairy over smooth stems. Of 185 hybrids derived from 12 different interspecific combinations, involving female parents with smooth stems crossed with males having hairy stems, all had hairy stems. Other examples of dominance in leaf and plant habit are the prominent leaf veins of *C. granthamania* (Figure 1) and *C. sinensis;* the narrow, elongated, peach-like leaves and the characteristic purple in new shoots of *C. hongkongensis;* and the willowy, spreading plant habit and dull gray-green foliage of *C. fraterna.*

Flower Characteristics

Flower size and form are usually intermediate between the parents in first generation interspecific hybrids. However, when small-flowered, wild species, such as *C. fraterna, C. lutchuensis, C. miyagii* and *C. kissi* were crossed with large-flowered cultivars of *C. japonica, C. rusticana, C. reticulata* and *C. sasanqua*, the small-flowered species appeared to exert the greater influence on the progeny. This would indicate a relatively homozygous condition for flower-size genes in the small-flowered species and a relatively heterozygous condition in the large-flowered species.

Species that contribute dominant floral characters are *C. granthamania* with large, elongated, frilled white petals; *C. hongkongensis* with trumpet-shaped, brilliant red flowers and rough gray sepals; *C. miyagii* with long, very narrow petals; and *C. saluenensis* with clear rose-pink illuminative color of the petals. Transmission of this floral character of *C. saluenensis* to many of its hybrids has in large part been responsible for the popularity of the *C.* x *williamsii* hybrids.

Flower Fragrance

Good flower fragrance is rather rare in *Camellia* and is only faintly present in some cultivated forms. Seven species are strongly scented: *C. lutchuensis*, *C. fraterna, C. kissi, C. miyagii, C. oleifera, C. sasanqua* and *C. tsaii*. Only *C. lutchuensis* and *C. tsaii* have a fragrance that is pleasant to most people, described as similar to that of *Osmanthus*. The odor of the other five species is described as musky and unpleasant. The floral fragrance of *C. lutchuensis* is transmitted to a large percentage of its hybrid progeny. However, the flowers of many of these fragrant hybrids are small to intermediate in size and sterile. One hybrid selection, 'Fragrant Pink', a *C. rusticana* x *lutchuensis* cross, was named by the USDA in 1966. The cultivar was also sterile, but by use of the drug colchicine its chromosome number was doubled and its unaborted pollen increased from 5 to 83 per cent. As a tetraploid cytochimera, it has been used for three seasons to produce new races of triploid and tetraploid hybrids.

New Potentials in Breeding

The majority of the lesser-known species have not gained acceptance because the overall quality of the plants and flowers is inferior to those of the cultivated forms already widely grown. Most of the F_1 hybrids are only the raw materials from which breeding projects with specific goals may be developed. Crossing these hybrids with fertile commercial cultivars should provide highly heterozygous and variable progenies. Selection among second- and third-generation hybrids probably will be necessary to sift out undesirable characteristics. From among these later generations, potentially valuable new types may be discovered which could lead to entirely new races of garden camellias.

A Bright Future

The possibilities of accumulating desirable characters through hybridization becomes increasingly evident as more interspecific and intergeneric hybrids reach maturity. Existing hybrids display a myriad of unique forms, including floral fragrance, new flower color types, spider petal forms, longer blossoming periods, far greater floriferousness dwarfed and prostate plants, and greater cold hardiness. These characteristics increase diversity, extend northward the usefulness of camellias grown outdoors and enhance their use for hanging baskets, as slow-growing house plants, and in small gardens.

"Opportunities for further improvement are almost infinite . . ."

BREEDING RHODODENDRONS AND AZALEAS

August E. Kehr

THE FIRST RECORDED RHODENDRON hybrid resulted from an accidental cross, made in the 1800's, between the broad-eaved *Rhododendron ponticum* and the deciduous pinxterbloom azalea, *R. nudiflorum*. Hybrids between rhododendrons and azaleas, called azaleadendrons, are but one example of the wide range of hybridization potential in the genus *Rhododendron*.

The genus, which includes both rhododendrons and azaleas, has about 800 species, few of which have been used in developing garden varieties of rhododendrons and azaleas. Hence the opportunities for further improvement are almost infinite, and there is ample opportunity for the rhododendron breeder to use his ingenuity, skill and imagination—bound by few restrictions.

Kinds of Rhododendrons

Rhododendrons are classified into two main groups—scaly-leaved (lepidotes) and nonscaly-leaved (elepidotes). The scales on the scaly-leaved types look like thousands of tiny umbrellas, which are faintly visible to the unaided eye. They are easily seen as in Figure 1, mainly on the undersides of the leaves, by using a good hand lens.

Before starting a breeding program, it is important that the prospective rhododendron breeder learn to recognize lepi-

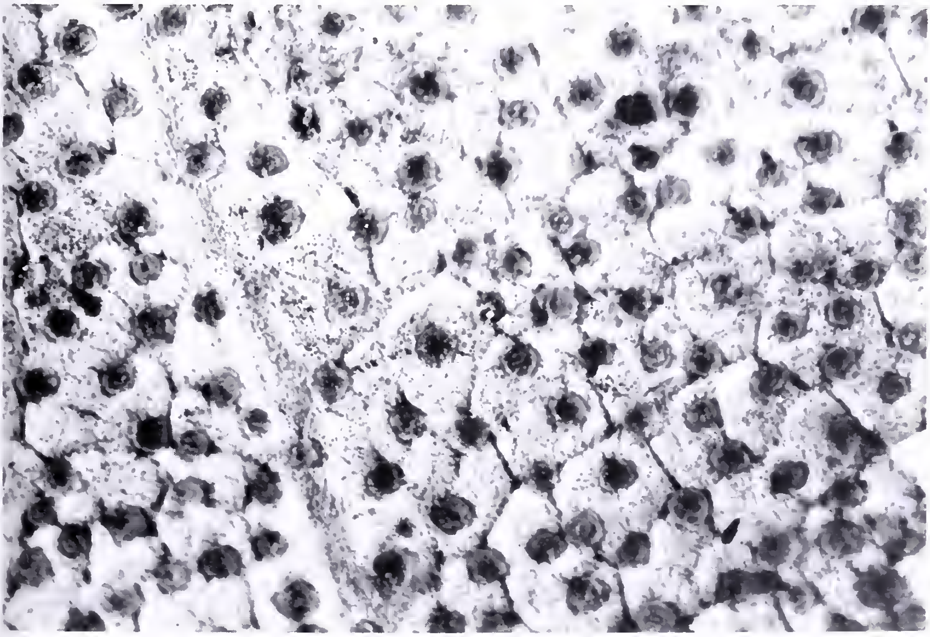


Fig. 1 The scales on the underside of a leaf of *Rhododendron racemosum* (much enlarged).

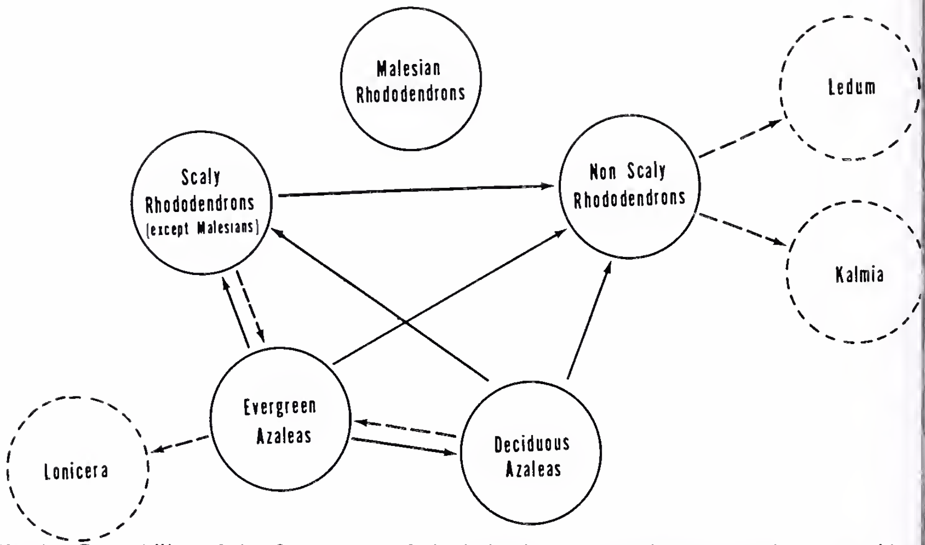


Fig. 2 Crossability of the five classes of rhododendrons, related genera and one outsider. Solid lines indicate successful hybrids can be obtained with difficulty, broken lines indicate little or no probable success. Crosses *within* each class are virtually limitless.

dotes and elepidotes, because, in general, crosses between them are extremely difficult to make, and the rare hybrids are seldom normal in growth.

The scaly-leaved sorts are further divided into two distinct types. One type includes several hundred tender species, found mainly in Southeast Asia, Australia and the East Indies, and known collectively as Malesian rhododendrons. The Malesians, unlike the rest of the lepidotes, have unique appendages on their seeds, which make the seeds look like tiny candy kisses. The Malesians have an unusual array of colors (especially brilliant yellows) and often flower two or more times per season. We know of no hybrids between the Malesians and the other scaly-leaved species.

The nonscaly-leaved rhododendrons have broad evergreen leaves. Plants may vary in size from nearly prostrate shrubs, as in *R. forrestii,* to trees, as in *R. arboreum.*

Thus, in rhododendrons there are three distinct classes—all so genetically isolated from each other that hybrids are difficult or impossible to make between the three classes. Fruitful breeding is limited to species and hybrids within the classes. These relationships are shown in Figure 2 on page 56.

Kinds of Azaleas

The azaleas are also nonscaly, but they generally have small leaves. They range from nearly prostrate forms of *R. nakaharai* to plants 12 to 15 feet high (*R. arborescens*).

Azaleas likewise are classified into two classes, deciduous and evergreen. The deciduous azaleas lose all their leaves during the winter, while the evergreen types retain their leaves in varying degrees from near-total retention *(R. macranthum)* to the loss of all except some in tufts at the twig tips *(R. poukhanense).*

Hybrids between deciduous and evergreen azaleas are difficult, but not impossible. For example, I have repeatedly crossed a flame azalea cultivar, *R. calendulaceum* 'Colossus' (seed parent), with *R. obtusum* 'Tahei' and 'Gettsu-Toku'. From these crosses, I get a good supply of seed, and the seed germinates well. However, none of the progeny is vigorous. In general, the hybridizer should devote his time to crosses of evergreen to evergreen types and deciduous to deciduous types, as indicated in Figure 2.

Wide Crosses

Venturesome hybridizers sometimes make unusually wide crosses between genera. The following have been reported.

(1) Mountain-laurel *(Kalmia latifolia)* ♀ x Williams rhododendron *(R. williamsianum)* ♂

(2) Mountain-laurel *(Kalmia latifolia)* ♀ x rosebay rhododendron *(R. maximum)* ♂

(3) Labrador-tea *(Ledum groenlandicum)* ♀ x *Rhododendron* 'Elizabeth' ♂

(4) Trumpet honeysuckle *(Lonicera sempervirens* 'Scarlet Trumpet') ♀ x snow azalea *(Rhododendron mucronatum alba* 'Indica alba') ♂

In general, such wide crosses are not successful. In the instances above, no research *proving* hybridity is known, although the author has examined the hybrid of *Kalmia latifolia* and *Rhododendron williamsianum*, and it appears to be a true hybrid. Plants from wide crosses may sometimes result from the functioning of the pollen cells alone or egg cells alone, and hence give rise to miniature haploid forms of either parent with one-half the normal chromosome number, as is probably the case in the third example above.

Storing Pollen

Inexpensive and practical techniques are available to every breeder today. They enable him to store rhododendron and azalea pollen almost indefinitely. Such storage of pollen permits us to make any pollination desired, despite months' differences in blooming, and despite the fact that continents may separate the parents. Following methods outlined on page 13 I have made successful crosses of deciduous and evergreen azaleas, and scaly and nonscaly rhododendrons, using pollen ranging in age from one to three years.

Selecting Parents

Before making crosses, the hybridizer should decide on the objectives he wishes to achieve. They may include one or more of the following: dwarfness, resistance to insects or diseases, cold tolerance, heat tolerance, fragrance, color, foliage color and quality, season of blooming, lasting quality of flowers, ease of rooting, or tolerance to air pollution. Parents should be selected which have characteristics that will help to attain your objective. For example, one of my objectives is to develop a yellow-flowered evergreen azalea. It may take a lifetime.

Objectives may be highly original or imaginative. Thus, for instance, there is no reason why someone should not develop rhododendrons to be used as shade trees if he wishes to do so, or ones that would flower in late summer or autumn, or that would grow in alkaline soil.

Seed

You may prefer to obtain high-quality seed elsewhere, rather than to develop your own. The American Rhododendron Society yearly provides its membership with a valuable seed exchange, listing more than 500 crosses and species.

The seeds may be planted at any time after they are spilled from the capsule. However, you must have space prepared for transplanting the seedlings about six to eight weeks after planting. Consequently, midwinter or early spring is the best time to plant, unless you have a greenhouse or have built structures in your basement (Figure 3).

For planting medium, a 50-50 mixture of peat moss and perlite (or clean sand if available) is put into flats or clay pots. After the surface of the planting medium has been smoothed and firmed, a ¼″—½″ layer of milled sphagnum moss (not sphagnum peat) may be spread on the surface to reduce danger of damping-off diseases. After the planting medium is well moistened, the seed is sprinkled lightly on the surface. No additional covering is required. However, the flat or pot must be covered with glass or plastic to keep the surface constantly moist. Subsequent watering is best done from the bottom by placing the flat or pot temporarily in a tray filled with water. Keep at temperature of 75° to 80°F. Germination requires three to five weeks. The germinat-

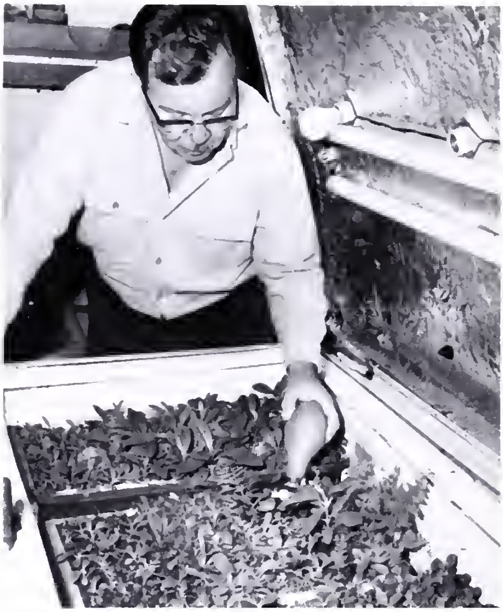


Fig. 3 An old refrigerator was used by Henry Yates in western Maryland to grow seedling rhododendrons. He found the temperature and moisture conditions could be correctly controlled by raising the lid slightly. Notice that he used both flourescent (cool white) and incandescent lights.

ing seeds require strong indirect light (never direct sunlight). Coolwhite fluorescent lights to provide a 16-hour day are excellent. The germinating seedlings must never be allowed to dry out.

The seedlings may be transplanted 1 to 2 inches apart in flats, filled with a 50-50 medium of peat-sand or peat-perlite, as soon as they have their second true leaves. This first transplanting is usually done six to ten weeks after planting the seed. Mixing in about one cup of calcium sulfate (also called gypsum or land plaster) per bushel of medium will be beneficial to the seedlings and is claimed to reduce losses from root diseases. Calcium sulfate provides the much-needed calcium mineral element for the plants, but it does not alter the acidity of the medium to any noticeable degree.

Growing On

The transplanted seedlings should be fertilized very sparingly, or even not at all. Fish-oil emulsion sprays, used according to directions, are excellent. Avoid inorganic chemical fertilizers, because the seedlings are easily killed.

The established seedlings may be put outside in flats under lath or high shade as soon as frost danger is over. A second transplanting 6 inches x 6 inches apart into beds may be done when seedlings reach a height of 2-½ to 3 inches. Care must be taken never to allow the young plants to get dry, because at this stage they have inadequate root systems and are easily killed by drying out. A very dilute foliar spray with a fungicide such as captan, every two to three weeks, will prevent damping-off. Winter protection from drying winds must be provided the first winter, either by laths or a plastic cover on a suitable frame. I have successessfully overwintered young rhododendrons by placing over them a light layer of dry leaves, covered with a plastic to keep the leaves dry. Moist leaves pack down and smother the tiny plants.

The following year, the plants should have developed adequate root systems to survive without lath or plastic covering through the second winter. Again use organic fertilizers, such as cottonseed meal, or use chemical fertilizers with extreme caution to avoid burning and killing the plants. The plants grow nicely even with no fertilization. ✿

Hundreds of different species are available to the hybridizer

HOLLY HYBRIDIZING PROGRAMS

Elwin R. Orton, Jr.

THE GENUS *Ilex* (holly) includes an extremely versatile group of ornamental plants. Hundreds of different species have been described. Both evergreen and deciduous trees and shrubs are represented, and the berry-like fruit may be red, orange, yellow, white or black. An intensive program of holly hybridization is currently being conducted at Rutgers—The State University of New Jersey. Development of cultivars which are novel and/or superior to those presently grown in American gardens is a primary objective of this work.

Proper Evaluation

The vast majority of holly cultivars named to date, and there have been more than 2600, are selections from the wild; only a very few have ever become widely distributed or accepted. The disparity between the number of hollies which have been named and the number which have proven worthy of commercial production attests to the need for thorough testing of current and future cultivars.

A cultivar performance trial is an essential starting point of any breeding program. Such trials make it possible to evaluate plants under reasonably uniform conditions at each test site and, thus, to to assess their genetic variability. Performance trials also provide parent material for hybridization and standards for evaluating new selections from the wild and from controlled matings. Obviously, large test sites are not something the individual holly enthusiast wishes to assemble or maintain. Fortunately, however, sizeable plantings of hollies have been established at various universities, arboreta and botanic gardens. Nineteen Official Holly Arboreta and four Experimental Holly Test Centers have been designated by the Holly Society of America.

A close look at the hollies in a performance trial reveals tremendous variability between clones in every plant characteristic of interest to horticulturists. Some of this variability is due to nonuniformity of soil conditions or site exposure in the test area and is environmental in nature, but much of the variation observed is the result of differences in the hereditary constitution of the plant material. This wealth of naturally occurring genetic variability, which is present in each species of *Ilex,* is sufficient for the needs of the hybridizer.

The heterozygosity (see page 9) of the genic material of hollies is a result of the dioecious nature of the crop. With minor exceptions, holly plants are either staminate (male) or pistiilate (female), and cross-pollination is the rule. Differences in floral structure and habit of flowering structure and habit of flowering exist between various species of *Ilex.* However, flowers of American holly *(I. opaca)* illustrate the basic differences between staminate and pistillate forms. (See Figure 1.)

Technique

In addition to insuring ample genetic variability for the breeder to manipulate, the dioecious nature of hollies simplifies the mechanics of achieving controlled pollinations. All that is required for a mating of known parentage is to transfer pollen from the anthers of a male flower to the stigmatic surface of the pistil of a female flower, under conditions which prevent the introduction of foreign pollen. This is readily achieved in the greenhouse by the use of small, potted flowering plants of the two parent selections. If a greenhouse is not available, one can keep potted plants indoors for a few days while they are in flower.

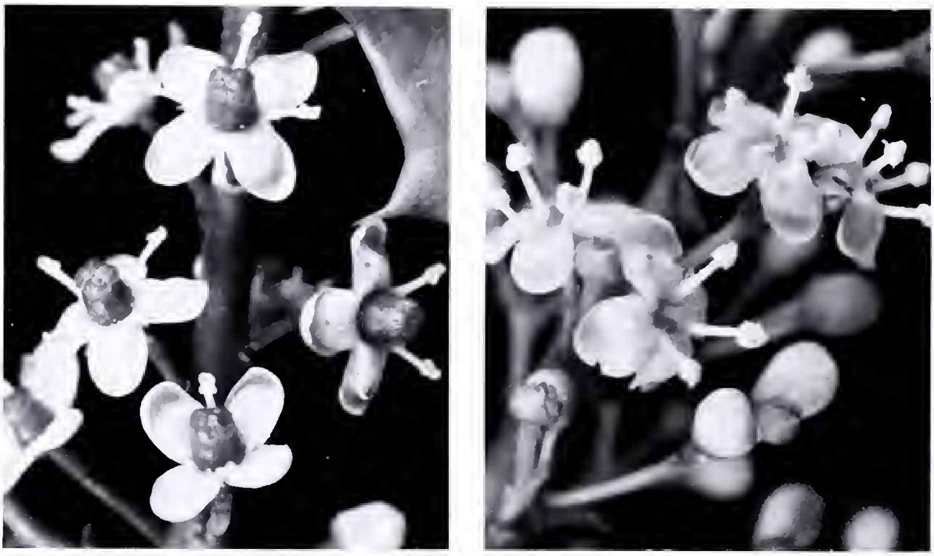


Fig. 1 Female holly flowers **(left)** are characterized by enlarged pistil surrounded by rudimentary stamens. Male holly flowers **(right)** are characterized by well-developed stamens surrounding a rudimentary pistil.

If the plants are in the garden, placing a wire cage covered with cheesecloth over them during flowering will exclude insects that might introduce foreign pollen. In the case of larger plants, it is easy to place bags over the branches of pistillate plants before the flowers open and then later, to rebag them immediately after the desired pollen has been introduced by hand. After flowering, the cages or bags are removed until autumn, when they should be replaced to prevent birds or other wildlife from pilfering the ripening fruit.

The fruits can be harvested once they have attained full color. The seeds are squeezed from them and the pulp rubbed off onto paper toweling. The cleaned seeds should be planted immediately; a simple technique is to plant them in milled sphagnum moss in a plastic tray about 7″ long by 5″ wide by 4″ deep. The sphagnum moss should be just slightly moist and the seed planted ⅛-¼″ deep. The tray can then be placed in a plastic bag and stored on a shelf at room temperature. Open the bag once a month to inspect the tray and to add water as needed. When seedling emergence occurs, remove the bag and place the tray in a well lighted area where growth can proceed normally.

Seedlings can be safely transplanted to a light soil mixture as soon as the first true leaves appear. Freshly transplanted seedlings are readily established and maintained in 2¼-inch pots until sufficiently large to warrant transplanting to 6-inch containers. Subsequent handling will depend upon the nature of the cross and the intended use of the seedlings. If the desired objective is anticipated in seedlings of the first generation, the plants can be planted directly in the garden; if the F_1 seedlings are produced solely to provide a means of obtaining subsequent generations and the F_1 plants are not expected to survive outdoors, they should be kept in the greenhouse.

Types of Crosses

Hybridization between holly clones of the same species is relatively simple. A given species of *Ilex* may include an array of morphologically and physiologically diverse genetic types, but a similarity of genes, or a more-or-less free interchange of genes, is maintained between individuals within the species. Thus, sterility barriers are rather uncommon in crosses involving different clones of the same species. Controlled crosses, conducted within a carefully planned schedule of matings and followed by critical evaluation of large populations of seedlings over an extended period of time, constitute the essentials of an intraspecific breeding program. Once a truly superior plant has been identified, many plants of the same genotype can be produced by asexual means (primarily stem cuttings).

Objectives of a breeding program vary with the hybridizer, the species and the climate. Considerable work at Rutgers University is devoted to the development of cultivars of American holly *(Ilex opaca)* which will survive lower winter temperatures than are encountered in the areas to which plants of this species are indigenous. Similarly, other breeders are attempting to develop cultivars of English holly *(I. aquifolium)* which will thrive under the relatively hot and dry conditions of the Southeast. Another goal is to produce cultivars with characteristics quite novel for a particular species. A major aim of the Rutgers program is to develop cultivars exhibiting the desirable growth habits of various clones of Japanese holly *(I. crenata)* and inkberry *(I. glabra)*, but possessing brilliant red fruit instead of the inconspicuous black fruit that is typical of these two species. This work involves crossing them with uncommon species such as *I. sugeroki* and *I. yunnanensis*.

Hybridization between species is usually more difficult than intraspecific hybridization. Chromosome numbers of different species are often a basis for deciding which crosses might succeed. However, in reality, compatibility can only be determined by trial-and-error. Even though an initial cross may be compatible, sterility may be encountered in the hybrid plants. Sterility of the interspecific F_1 hybrids is a major barrier in producing cultivars which combine the winter hardiness of American holly with the attractive foliage and fruiting characteristics of English holly. (See Figure 2.) Matings such as this, involving species in which flowers are produced on the growth of the current season and species in which flowers are produced on the growth of the previous season, have been particularly unrewarding in *Ilex*.

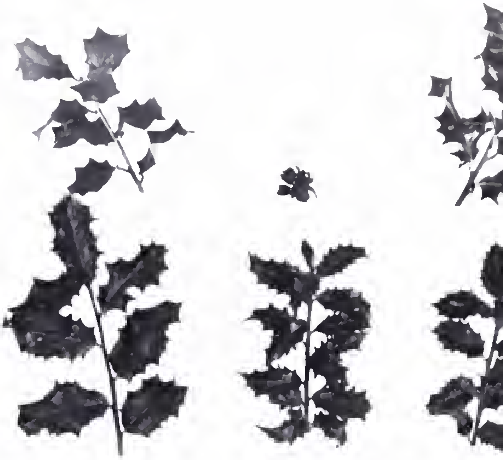


Fig. 2. *Ilex opaca* 'Hedgeholly' **(left)** crossed with *I. aquifolium* **(right)** and resulting F_1 hybrids. Abnormal plants, such as the genetic dwarf shown in the center, appear frequently among interspecific hybrids.

In crosses where fertile interspecific hybrids are obtained, a tremendous diversity of types can be expected in the F_2 generation as a result of the extremely heterozygous nature of the F_1 interspecific hybrids. In such cases, there is always the possibility that novel types unlike either parent may be present. If worthy, such types can be perpetuated by cuttings.

Undoubtedly, many amateur breeders have avoided working with genera such as *Ilex* since hybridization of woody plants is a long-term proposition compared to breeding work with annuals or other herbaceous plants. However, recent introductions such as *Ilex* x *meserveae (I. rugosa* x *I. aquifolium)* 'Blue Girl', 'Blue Boy', 'Blue Prince' and 'Blue Angel', all stemming from the hybridization work of Kathleen K. Meserve of St. James, New York, are proof that a dedicated amateur can achieve notable results in the breeding of woody ornamentals.

Breeding efforts are concentrated on three well-known species

BREEDING PROGRAMS FOR DOGWOODS

Elwin R. Orton, Jr.

THREE of the best known flowering dogwoods *(Cornus florida, C. kousa* and *C. nuttallii)* are the subject of intensive breeding work at Rutgers—The State University of New Jersey. These species have multiple seasons of interest including their spring flowers, autumn foliage color and berries, and the winter attraction of distinctive bark and branching habit.

Cornus florida is native to most of the eastern half of the United States, where it is one of the most popular of all small flowering trees. To many gardeners, it is simply "dogwood," although there are other *Cornus* in the East and, all told, about forty species in various parts of the world. Thousands of eastern dogwood trees grown from seed are sold each year, but selected types, propagated by budding, are available as named cultivars and are more worthy of attention.

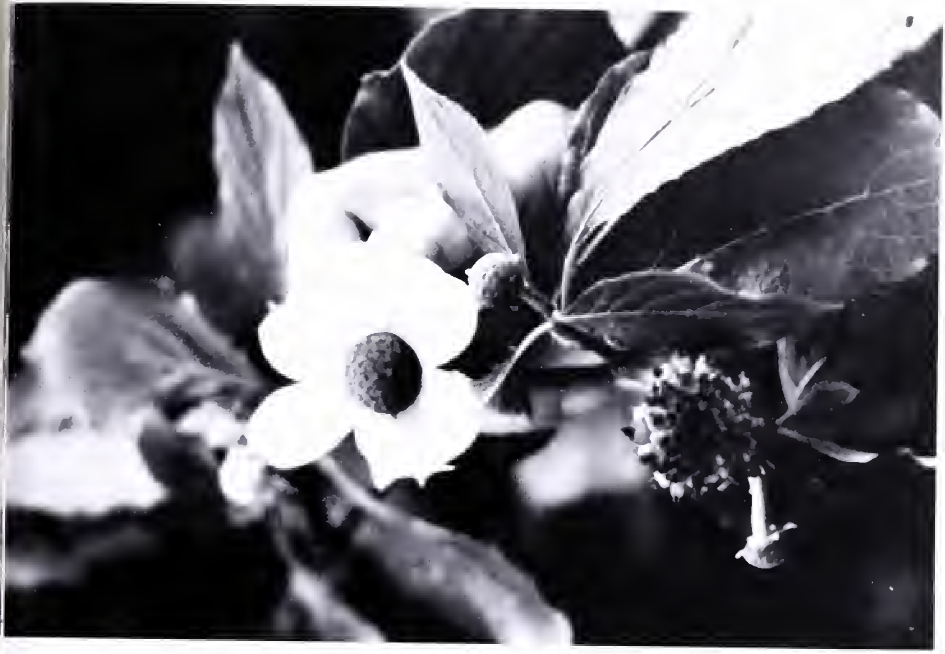
The development of better pink- and red-bracted forms of eastern dogwood is a major breeding objective. The pink- and red-bracted cultivars available today originated as chance seedlings in the wild and were introduced to the nursery trade because of their unique bract color even though other horticultural characteristics were not outstanding.

As many northern gardeners have learned to their dismay, lack of winter hardiness can be a real problem with dogwood cultivars selected in the South because their floral bracts may be damaged by severe winter temperatures or late spring frosts. The true flowers, which are surrounded by the large bracts, are small and relatively inconspicuous.

Introduction of the red-bracted characteristic into the Japanese dogwood *(C. kousa)* is another breeding goal. Red-bracted forms of this species are not yet known but would quickly become popular if developed. Japanese dogwood trees are typically vase-shaped, while eastern dogwoods are noted for their horizontal branching. Loss of flower display due to late spring freezes is not a problem with Japanese dogwood because in the mid-Atlantic states it flowers in June, a month later than eastern dogwood. Hybrids between eastern and Japanese dogwoods offer the possibility of clones intermediate in both growth habit and flowering season. It is to be hoped that resistance to the dogwood borer, a very serious insect pest of *C. florida,* will be an added bonus in such hybrids since *C. kousa* appears to be much less subject to borer attack.

The Pacific dogwood *(C. nuttallii)* is native to a coastal strip from British Columbia to California. Although it is the giant of the dogwoods, growing to 60 feet in the wild, the Pacific dogwood seldom survives for long periods when planted in the East. 'Eddie's White Wonder', a hybrid of the two species, is being widely tested but does not perform much better in the East than its western parent. As with *C. kousa,* red-bracted forms of *C. nuttallii* are unknown.

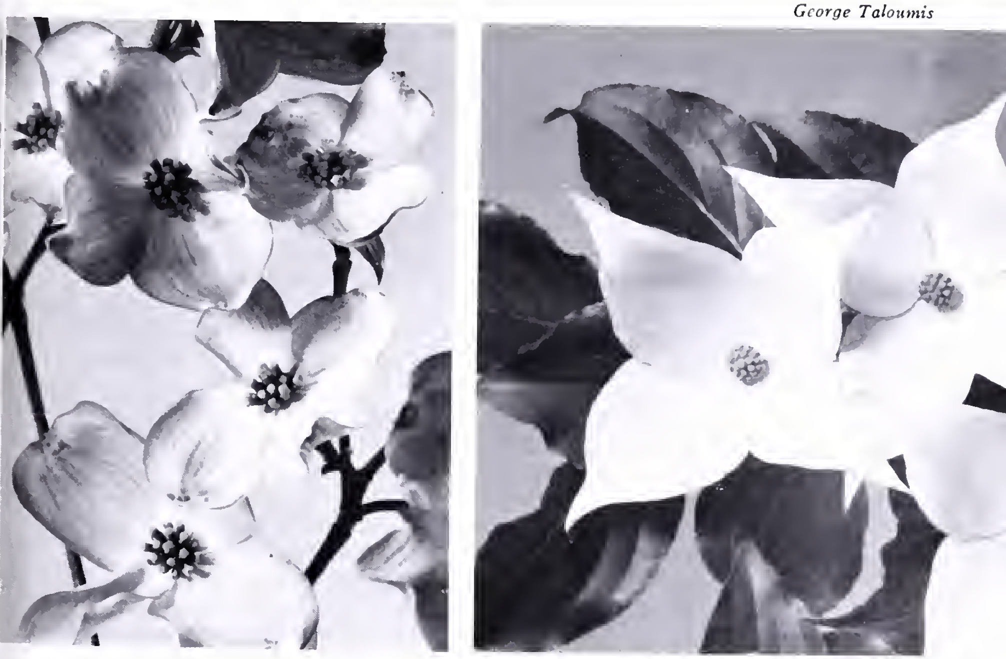
Further hybridization of 'Eddie's White Wonder', as well as other F_1 hybrids of *C. florida* and *C. nuttallii,* with *C. florida* and/or *C. kousa* may well produce large-bracted hybrids that thrive beyond the restricted native range of *C. nuttallii.* More assuredly, hybridization of *C. nuttallii* with red-bracted forms of *C. florida* can be expected to yield red-bracted trees of a *C. nuttallii* type for planting in gardens of the western United States. ☘



Elizabeth Scholtz

THREE FLOWERING DOGWOODS OF INTEREST TO THE HYBRIDIZER: **Above:** A branch of the Pacific dogwood *(Cornus nuttallii)* held for the photographer to show both flower and fruit. The fruits are from the spring flowering. The Pacific dogwood often has recurring bloom in late summer—when this photograph was taken. **Below, left:** Flowers of *Cornus florida* and **right,** flowers of the Japanese dogwood, *Cornus kousa.*

George Taloumis



New challenges with the queen of garden shrubs . . .

HYBRIDIZING POSSIBILITIES IN THE LILAC

John L. Fiala

THE LILAC GENUS *(Syringa),* which contains about 25 true species, has many untapped opportunities for hybridization, although breeding has gone on for many years. For centuries, in fact, selections have been made of the common lilac *(Syringa vulgaris),* and numerous excellent cultivars have been introduced by European and American breeders. Although the common lilac is native to southeastern Europe, it and its cultivars are now planted in cool-climate gardens around the world.

The noted French nurseryman, Victor Lemoine, opened up many possibilities of interspecific hybrids when he produced his cross between a common lilac cultivar *(S. v.* 'Azurea Plena') and an Asiatic species, the early lilac *(S. oblata).* This hybrid was introduced in 1878. No doubt excellent results would be had by repeating Lemoine's cross today, but using better cultivars of double-flowering *S. vulgaris (e.g.,* 'Alice Harding', 'Leon Gambetta', 'Maréchal Lannes') with some of the more select forms of *S. oblata,* including its botanical varieties *dilatata* and *giraldii.*

Traits to Pursue

Lilac breeders may seek many objectives. There should be a greater improvement in color, such as bluer blues, redder reds, and especially yellower creamy-whites. And these colors should be incorporated into some of the newer floret forms, such as the primula types with multiple petals so pronounced in the Rochester Strain of common lilacs, which was introduced by the Monroe County Parks System, Rochester, New York recently.

The beautiful colors and flower forms of the common lilac, of which there are over 1,000 recorded cultivars, are but one challenge. An entirely new area for the lilac hybridizer is to work for colored seed pods that would make it a two-season shrub. Lilac pods have already been selected in a few cultivars in colors of pale cream, pink and red, particularly deep lavender red. To date this pod color lasts only a few weeks, but it is a beginning. A persistent breeder could make a notable contribution in this area alone.

Fall foliage color is another trait worth pursuing. Some varieties of *S. oblata,* namely *dilatata* and *giraldii,* have a fine show of autumn colors. With breeding and selection this could be enhanced. Ornamental lilacs resistant to diseases such as bacterial blight and powdery mildew, or to air pollution, are also needed.

Lilacs now come in many growth habits —tall, medium and dwarf, also narrow and spreading, although not all of these are commonly available in the trade as yet. Breeding for better growth habits with heavier bloom would be most worthwhile. A lifetime could be spent breeding the common lilac alone.

Late-blooming Lilacs

Perhaps the greatest opportunity for hybridizing is among species of the Villosae Series, or late-blooming lilacs. Isabella Preston in 1920 made her famous crosses of *S. villosa* and *S. reflexa,* producing the large group new called the Preston Hybrids, and an entirely new chapter in lilac breeding was written. Extensive hybridization of these and other lilac species has really just begun.

The late-blooming lilacs have a limited color range but the genetic material is there to extend this range. They already exist in white, bluish-lavender, pink to carmine, and deep purple. The floret size needs improvement as does the blossom

Foliage and flowers of *Syringa pinnatifolia*, a lovely small-leaved lilac species as yet unused in hybridizing.

CLASSIFICATION OF LILAC (SYRINGA) SPECIES

SUBGENUS EUSYRINGA

Series Villosae

emodi
josikaea
komarowii
reflexa
sweginzowii
tigerstedtii
tomentella
villosa
wolfii
yunnanensis

Series Vulgares

julianae
laciniata
microphylla
oblata
patula (meyeri, palibiniana and *velutina)*
pinetorum
potaninii
pubescens
rhodopea
vulgaris

Series Pinnatifoliae

pinnatifolia

SUBGENUS LIGUSTRINA

pekinensis
reticulata (amurensis)

There is disagreement among authorities about the status and classification of some species. Hybrids between Series Villosae and Vulgares are rare or non-existent at this time; also between the two subgenera.

head. The often rank growth of some of these hybrids and the space needed to grow them have been deterrents to the hybridizer as has their atypical fragrance, which is lovely nonetheless. Many excellent opportunities exist for developing better floral shapes with better color, shorter plants, and remontant habit (blooming twice a year). The various species can provide some spectacular specimen plants (*S. komarowii* and its hybrids), very dwarf shrubs (in certain forms of *S. patula,* actually a member of the Vulgares Series), and hedges (*S. villosa* and its hybrids).

Among lilac species that have been little used but should be hybridized are *S. tigerstedtii, S. rhodopea, S. yunnanensis, S. tomentella* and the lovely *S. potaninii.* The nodding lilac (*S. reflexa*) has many desirable characteristics and has been used more extensively than others. Some of the species do not appear to have a great deal to offer in plant or flower improvement, yet crosses with them should be made, carefully tested, and carried at least to the second generation. They may well contain recessive genes with desirable characteristics such as lateness of bloom, drought resistance, winter hardiness or plant vigor that should be incorporated in the lilac hybrids of the future. *S. sweginzowii* and its form *albida* are graceful and plume-like with a fragrance all their own. *S. komarowii* is an annually heavy bloomer and the attractive *S. tigerstedtii* is relatively unknown.

The late-blooming tree lilacs, *S. reticulata (amurensis)* and *S. pekinensis,* have not yet been successfully crossed with other species. There are rewards here for the patient breeder who could accomplish this seemingly impossible hybrid. Even without it, though, selected clones of the Amur tree lilac (*S. reticulata*) should be intercrossed and improvements made in its form and flower.

Natural polyploids are not known, but in the past several years tetraploids and even octoploids of many lilac species have been made and should soon be available to hybridizers. These offer the possibility of producing fertile hybrids between different subgenera.

Hybridizing Technique

The lilac blossom is rather small and care must be taken in emasculating the floret not to damage the pistil. In the late-blooming species, emasculation is very simple because the anthers are pulled off readily with the petals, leaving the pistil exposed. Florets must be emasculated before the floret petals open or the blossom will have already self-pollinated. Far less cross-fertilization occurs from wind and insects than was formerly thought.

Pollen can be easily dried and stored in a refrigerator. Freshly pollinated blooms should be bagged to keep insects away and to prevent the delicate pistils from being seared by hot sun, since the protective shade of the petals has been removed. The bags should be removed within a week of pollination to prevent rotting or mildew of the seed pods. ❧

Better Lilacs for the Cities?

THE BROOKLYN BOTANIC GARDEN has conducted a research program to select and develop better lilacs for city conditions. The work has taken place at the Garden's Kitchawan Research Laboratory, Ossining, New York, by Research Pathologist Craig R. Hibben. He has spent the last several years studying how air pollutants affect lilac species and cultivars in or near New York City, Philadelphia and Boston. In cooperation with former staff member Jerry T. Walker, the data are being analyzed at the University of Georgia computer center. Recommendations of pollutant-resistant lilacs suited to city environments will soon be available.

"In this day of instantaneous results, there is an inner satisfaction from involvement with long-term goals . . ."

HYBRIDIZING NUT TREES

Richard A. Jaynes

Is THE EXCITEMENT of experimenting with the unknown and having the chance of finding uniquely superior nut trees worth the effort of growing hybrid seedlings? For many amateur breeders it is. Hand pollination of trees is often not difficult but even if the breeder is reluctant to do this, hybrids can be grown without resorting to controlled crosses. One need only take advantage of special situations that exist in nut tree plantings.

I would like to suggest that we need to grow more nut trees from crosses of different species, especially in parts of the United States where these trees are not an important commercial crop. Species hybridizing is not an exclusive alternative to the selection of seedlings from named cultivars, but it is a desirable complementary approach. Growing seed from a species' outstanding individuals that have been allowed to naturally cross pollinate, and then selecting the best seedlings, while a time-proved technique, is a rather conservative means of obtaining improved cultivars. When the parents of a cross are similar, the chances of recovering offspring that vary greatly from them are limited.

Fortunately the common nut tree genera—hickory *(Carya)*, walnut *(Juglans)*, filbert *(Corylus)* and chestnut *(Castanea)* each contain several species. Within each genus the species usually can be successfully intercrossed. The variation within each group is of special importance to the breeder. Recombining superior traits from the best trees into superior individuals is what breeding and selection are all about. Often the character we want to add to a species does not occur in any of its varieties—for example, full development of the kernels of pecan nuts in areas with relatively cool summer temperatures. By appropriate crosses between pecan *(Carya illinoensis)*, which is botanically a hickory, and other hardy hickories, it should be possible to develop "pecan" trees for the North.

Hickories

The hickories are notorious for their variability, and many natural hybrids among North American species are known. Hardy, productive hickory cultivars could probably be developed from second generation crosses between the pecan and the shellbark *(C. laciniosa)* or shagbark hickory *(C. ovata)*. Of course there is an investment of time. However, in this day of instantaneous results, there is an inner satisfaction from involvement with long-term projects with specific goals, whether they mature in our lifetime or not. The hickories could well be the most challenging group to work with because of the long period, up to 20 years, it takes from seed to fruiting. Yet, new cultivars of pecan developed by U.S. Department of Agriculture researchers at Brownwood, Texas often begin to bear in the third or fourth year. This is a valuable characteristic to transfer into shagbark or shellbark hickory.

Walnuts

Dr. John McKay, now retired from the USDA, has grown many seedlings from second generation natural hybrids of the Persian *(Juglans regia)* and the native black walnut *(J. nigra)*. To date the seedlings that have fruited are not outstanding, but if enough are grown there should be one that recombines the hardiness of the black walnut with the easy cracking nut and self-shucking husk of the Persian, which is the common table walnut. There are other promising possibilities in the genus involving crosses among butternut *(J. cinerea),* heartnut *(J. sieboldiana* var. *cordiformis)* and Persian walnut.

Filberts

Many of the filbert (hazel) species, of which there are about 15, hybridize with ease. As with hickories, the opportunities for species crosses and selection in later generations have hardly been touched upon. 'Bixby' and 'Buchanan' are hybrids between the American filbert *(Corylus americana),* which is noted for its winter hardiness, and the large-fruited European filbert *(C. avellana).* They were produced by the nurseryman J. F. Jones in Pennsylvania fifty years ago. Desirable traits of the two parental species, not fully expressed in either of these hybrids, could be recovered among second generation seedlings. If the two hybrid clones were grown in an isolated planting they should intercross and hand pollination would not be necessary to produce the second generation hybrids.

Chestnuts

The chestnuts are an extremely variable group, composed of thirteen species.* The nut weight of the largest Japanese *(Castanea crenata)* or European chestnut *(C. sativa)* can be thirty times greater than that of the smallest chinkapin *(C. pumila).* Fruit maturity occurs from the first week of September to the last of October, growth habit varies from small shrubs to tall trees, and resistance to the chestnut blight fungus ranges from the near immune to the highly susceptible. In fact, virtually all traits of chestnut show wide variation among the species. There is no reason, in theory at least, why we cannot select those traits in which we are most interested and, by proper crossing and selection, develop trees with the desired combination of characters.

Why not just grow blight-resistant Chinese chestnut *(C. mollissima)* seedlings, which often produce good nuts, from our best Chinese selections? Because certain desirable orchard or ornamental traits, such as dwarf habit and columnar growth, may not exist within this one species. Chestnuts, with proper selection, can be first-rate garden trees as well as fruit bearers. An interesting species cross with ornamental possibilities is that between the Seguin chestnut *(C. seguinii)* a prolific, non-hardy dwarf and the Chinese chestnut, which is hardy, blight resistant and has large nuts. The F_1 generation is intermediate and the F_2 generation enables us to segregate the many traits of the two parental species.

A Simple Breeding Method

The mechanics of making controlled crosses may be a hindrance to producing hybrid nut trees, but as with the filberts there are ways to skirt this problem. We can illustrate with the hickories how a back-cross might be made without hand pollination. As already mentioned, first generation natural hybrids between shagbark (or shellback) hickory and pecan are known. If we have one of these "hican" clones in a planting where there are no other hickories except pecans, then it can be assumed that all of the nuts collected from that hican will have been pollinated by the surrounding pecans. (Nut trees preferentially out-cross.)

Seedlings from such a "back-cross" will vary from the two extremes of being predominantly pecan in type to half-and-half in the balance of characters they inherit. Among a large group of such seedlings, a few might have the desirable pecan-type nut but also the ability to fill nuts during cool summers or short seasons. Other plantings of nut trees may offer similar means to collect hybrid nuts without resorting to hand pollinations; for example, an isolated pecan among native shagbarks could be expected to produce hybrid hican seedlings.

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* An interview with Dr. Jaynes on the American chestnut appeared in PLANTS & GARDENS, Vol. 26, No. 4 (Winter 1970-71), pp. 7-11. Back copies of this issue are available for $1.00 each from the Brooklyn Botanic Garden, Brooklyn, N.Y. 11225.

The principles of hand pollination are the same for the four tree genera mentioned. The female flowers are isolated in a bag before they are receptive to pollen. When the female flowers become receptive, pollen from the desired male parent is applied. If the cross is successful, the resulting nuts will produce hybrid seedlings.

Space to grow trees and some assurance that they will not be destroyed before they set fruit is a real problem. If an area cannot be provided on private lands, public or private institutions, such as schools, parks or hospital grounds, should be made available to the serious amateur for growing his seedlings.

Nut tree breeding does require a long commitment, not necessarily in time spent in any one year, but a sustained effort over the years. Those interested should become as familiar as possible with what has been done and the material available. Information on the trees, hybrids, and crossing technique is contained in the *Handbook of North American Nut Trees,* available for $9.00 from the Northern Nut Growers Association, 4518 Holston Hills Rd., Knoxville, Tennessee 37914. ☙

A second generation hybrid chestnut, the result of a cross between the Chinese and Seguin chestnuts. It is more dwarf and prolific than the Chinese parent and more hardy and blight-resistant than the Seguin.

"There would seem to be an orchid for every taste or need . . ."

SOME ASPECTS OF ORCHID BREEDING

Gustav A. L. Mehlquist

PROBABLY NO GROUP OF PLANTS has ever brought so much pleasure to so many people as the orchid family (Orchidaceae). There are many reasons for this, the most important being the singular beauty of the flowers. Orchids are found in almost every part of the world from the coldest areas to the tropics. Some are found growing in soil, as are most other plants, while others are epiphytes growing on trees. They vary in size from an inch high to several feet. Some have flowers so small that their full beauty cannot be appreciated without a magnifying glass. Others have flowers several inches in diameter.

There would seem to be an orchid for every taste or need, but man, with his usual dissatisfaction with things as they are, has been busy for more than a hundred years trying to improve on nature. Purists would say you cannot improve on nature, but Mother Nature herself has led the way by providing man with numerous beautiful hybrids of her own—hybrids which often combine the best features of the parents.

Ever since John Dominy flowered the first man-made orchid hybrid, *Calanthe dominyi,* in 1856, from *Calanthe furcata* with *C. masuca,* more hybrids probably have been recorded in this plant family than in any other. Not every one has been better than its parents, but many have been pleasant surprises. By intercrossing

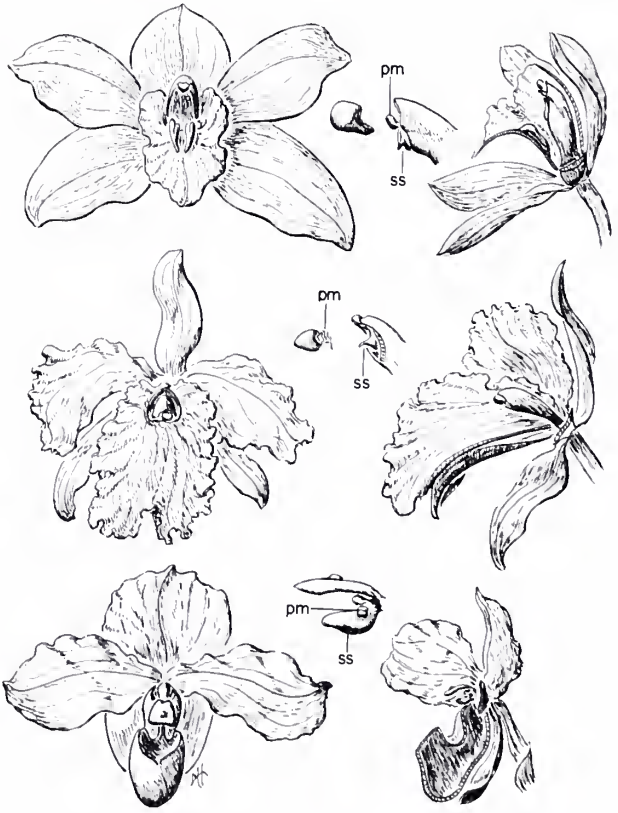

Figure 1
Top row: *Cymbidium.* In center is the upper portion of the column with anther cap removed. pm = pollen masses or pollinia; ss = stigmatic surface or cavity.
Center row: *Cattleya.* In center the anther has been detached showing the basal appendages of the pollinia protruding (pm); ss = stigmatic surface or cavity.
Lower row: *Paphiopedilum.* pm = one of the double pollen masses; ss = stigmatic surface.

he best of the hybrids and again selectng the best, orchid hybridizers have succeeded in gradually producing hybrid groups which are often superior to the pecies in appearance, at least from cerain points of view. Many hybrids have also been much more satisfactory in ease of culture and flower production.

This superiority is due to several facors. First, the successful hybridizer does not haphazardly cross any plants that come to mind but selects parents whose combined features come the closest to his goal. This selection frequently involves parent plants which differ greatly in habit of growth and flowering season. The resulting hybrids often show a blend of parental characteristics that defies accurate analysis. This is because the parent plants are likely to differ in a large number of characteristics. With typical dominance or recessiveness being largely absent or subdued, the results are sometimes difficult to assess. In part, this difficulty is due to the fact that when clear-cut dominance or recessiveness is not apparent, one looks for intermediacy, but intermediacy can be of different types.

Flowering Times

When the *Cattleya* hybrid Enid *(C. mossiae* x *C. warscewiczii)* was first produced in 1898, a spring-flowering hybrid was expected. Instead, a hybrid population was obtained which tended to flower the year round, with peak production in autumn. The behavior of Enid is really not so peculiar if one takes into account the behavior of the parent species. *Cattleya mossiae* produces a pseudobulb, leaf and sheath during the summer, then goes virtually dormant during the winter months. It resumes growth formation of a flowering spike, which blooms in mid- or late spring.

The other parent species, *C. warscewiczii,* produces a new pseudobulb, leaf, sheath and flowers all in one cycle, flowering in late spring or early summer. The plants then go dormant and remain so until late the following winter, when again the growth cycle resumes. To be sure, in cultivation, *C. warscewiczii* will often produce off-season pseudobulbs, some of which flower at irregular intervals, but orchid growers learned long ago that the greatest number of high-quality flowers could be obtained by keeping plants of this species dormant for the same length of time as would prevail in their natural habitat of Colombia.

When the genes of these two species were combined in the hybrid, both groups of genes apparently remained active. The result was a hybrid which grows and flowers at various times in the year. However, as the plants become older the flowers tend to peak in autumn, which is really an intermediate season of flowering. That is, when the cross was first made, the hybridizers expected an intermediate season between, say, March and May but received an intermediate season between May and March on the *other* side of the seasonal clock.

On the other hand, when two species of the same type of growth and flowering are crossed, the results are usually intermediate over the short distance on the seasonal clock. *Cattleya* Trimoss, a hybrid between *C. trianae,* which flowers in January and February, and *C. mossiae,* which flowers in April and May, usually blooms in March, with variations in flowering season related to the exact flowering time of the parents, both of which have two-cycle growing seasons. Likewise, *Cattleya* Dupreana, a hybrid between *C. warscewiczii* and *C. warneri,* both of which are one-cycle species blooming in late spring or early summer, flowers regularly at the expected summer season. In short, when the parent species are of the same growth and flowering habits, the flowering date may be expected to be intermediate over the shortest distance on the clock, whereas if the parent species are of different types intermediacy over the long distance may be expected.

Polyploidy

Polyploidy is another feature which has proved to be important in orchid breeding. In the genera *Cymbidium Paphiopedilum, Phalaenopsis* and the members of the *Cattleya alliance (Brassavola, Cat-*

tleya, Laelia and *Sophronitis)* polyploidy has been of extraordinary effect, first because both greater size and hybrid vigor have been obtained in crosses between closely related species and, secondly, because the triploids, which can usually be produced with ease, have been almost as large as the tetraploids in size and yet tend to grow with the speed of the diploids. Triploids thus have proved themselves good as flowering plants but poor as breeders.

Because triploids are generally poor breeders, further breeding from crosses involving diploids and tetraploids may be difficult unless occasional fertile tetraploids occur. A few tetraploids are likely to occur in crosses where triploids are normally expected, but they are more likely to occur if the diploid is used as the seed parent rather than the other way around. The breeder of cut flowers usually pollinates the tetraploid with the diploid in order to produce maximum numbers of triploids, whereas the developmental breeder uses the diploid as the seed parent to obtain maximum numbers of fertile tetraploids to facilitate further breeding.

Pollination

The process of pollination is very simple. The two main types of flower structures encountered in orchids are shown in Figure 1.

In the *Paphiopedilum* group the pollen is contained in two somewhat sticky double pollen masses, one on each side of the sterile staminodium. Pollination is effected by transferring one of the pollen masses (technically known as a pollinium or, plural, pollinia) to the stigmatic surface directly below the staminodium. A flat toothpick is excellent for this transfer because the sticky pollen mass adheres readily to its flat surface. The transfer is greatly facilitated by removing the lip or pouch of the flower, as one can then more easily see where to place the pollen.

In the *Cattleya* group and in other orchids a solitary dehiscent anther is located on the top of the column. This anther is readily removed, revealing from two to eight pollinia. In contrast to the *Paphiopedilum* pollinia, they are usually not sticky, though equipped with some sort of sticky appendages. The stigmatic surface is most often in the form of a small cavity located just below the anther. Ordinarily the stigmatic surface is quite sticky due to a sugary substance.

In nature most orchids are pollinated by insects and, therefore, often cross pollinated. The insect enters the flower by squeezing between the lip and the column in order to get to the nectaries, which are usually located at the base of the column. When the insect backs out of the flower the anther is apt to come off and the pollinia, by virtue of their sticky appendages, are likely to become attached to the back of the insect. If, when the insect enters the next flower, the pollinia come in contact with its sticky stigmatic surface they will probably adhere to this surface and be removed from the insect's back. Pollination is now complete and, if it is a compatible one, the pollen will germinate, producing long tubes that will carry the gametes through the stylar tissue down to the ovules located in the ovary, which is situated immediately below the flower.

For artificial pollinations in the *Cattleya* group as well as in the *Paphiopedilum* group, the toothpick is again the simplest tool. If the pollinia fail to adhere to the toothpick, it should be coated with some of the sugary substance exuded by most orchids at the base of each flower.

Sometimes it is desirable to make crosses between plants which do not flower at the same time. In such cases it becomes necessary to store the pollen for a while. Fortunately this is easily done with orchids. The sticky pollinia from the paphiopedilums are removed shortly after the flower is open and attached to the inside wall of a small vial. The vial should be stoppered with a cork or cotton plug and stored in a refrigerator at approximately 40° F. The dry pollinia from other orchids can be stored the same way but many breeders find it more practical to put the pollen in the small gelatin capsules which druggists use.

Refrigerated pollen can be kept in good ondition for several months and, with ome genera, for a year or two. The age f properly stored orchid pollen does not eem nearly as important as the age of the ower on which it is used. Since the ower apparently has to provide most of he hormones necessary for germination f the pollen on the stigma and the consequent growth of the pollen tubes down hrough the stylar tissue, the pollination hould be made as soon as the flower is ully open.

When crosses are made between plants having flowers which differ greatly in size, uccess is often attained only when the maller-flowered plant is used as the seed parent. Also, early pollinations are frequently more successful than later ones. n both cases such results are probably elated to pollen tube growth.

If a pollination is successful the flower usually senesces within two days to a week and the ovary begins to swell, indicating that fertilization has taken place. Maturation of the resulting seed pod may ake from six to fifteen months, at which ime the pod should be cut off before it begins to open. If the pod is left on the plant until it begins to open, the seeds may become infected with various microorganisms which in turn may lead to rouble in germination.

In crosses between widely separated species or genera, success is often enhanced by removing the pod when it has reached only about three-fourths maturity. In such cases the seeds must be planted within a few days. The planting of he seeds and the subsequent care of the seedlings is an art and a science in itself, and many successful hybridizers prefer to send the seed pods to a commercial laboratory for germination and care of the seedlings until large enough to be removed from the culture flasks.

Breeding Advice

In orchids a tremendous amount of breeding data is available in various publications, and orchid growers of today are known for their willingness to share experiences and breeding materials as well. Since so much hybridization in orchids has been done at the interspecific level where partial sterility often results, it is often more rewarding to use a proven parent in a new combination than to try two new ones.

In the *Cattleya* Enid and Trimoss crosses referred to above—and these crosses have been made several times—some have been much more valuable than others due to genetic differences among the parent plants within the same species. In fact, some of the less successful combinations have been made by the same hybridizers who had produced highly successful ones earlier; they could not reproduce their earlier successes because they had not kept track of precisely what plants were used in the early crosses other than to record the species to which they belonged. Because the time and expense in raising orchid hybrids is much greater than in many other plants, it may well pay to temper one's pioneer spirit by taking time to find out what others have done and, if possible, to obtain some parent plants that have proved themselves. An experienced breeder judges a parent not so much by its appearance as by what it produces.

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MAGNOLIA BREEDING POSSIBILITIES

J. C. McDaniel

Hybrids: Old, New and Rare

Hybrids of a few kinds are already among our commonly planted magnolias. The accompanying table shows that most of the magnolia species currently grown in the United States have each produced one or more hybrids through interspecific crossing. Among named cultivars, a very large proportion of the trees now being propagated are two hybrids, the Loebner and the saucer magnolias *(Magnolia* x *loebneri, M.* x *soulangiana).* The former is notably represented in the nursery trade by the cultivar 'Merrill', and the latter, in its various color forms, is well known to gardeners everywhere.

Although several cultivars of southern magnolia *(M. grandiflora)* are being propagated, it and most other American species are usually available, if at all, only as unselected seedlings. There are two other very commonly grown magnolias, both shrubby. Star magnolia *(M. stellata,* sometimes classified as a variety of *M. kobus),* which flowers in early spring, is mainly propagated from a few selected clones. 'Centennial', recently released by the Arnold Arboretum, is the largest-flowered cultivar. The lily-flowered magnolia *(M. liliflora),* noted for its recurrent bloom, is usually sold as var. *nigra,* though what goes under that name is not standardized.

The various species, as well as the popular hybrids, are still capable of improvement for garden use. For the future, hybrid combinations that as yet have not been extensively tried promise brighter, more fragrant and hardier magnolia cultivars than are now found in the common saucer magnolia *(M.* x *soulangiana).*

Examples already flowering of intersectional hybrids (in the botanical sense) and of some promising American-Asiatic hybrids (within the two subgenera, Magnolia and Yulania) suggest that both these approaches to breeding are worthy of consideration. Informed amateurs can, with patience, breed magnolias. If you would like to try hybridizing within this genus, the information contained in the publications of the American Magnolia Society can be invaluable.

Two of the earliest recorded magnolia hybrids were intersectional. In the early 1800's *M.* x *thompsoniana* arose as a seedling at Mr. Thompson's nursery near London, where he had both its American parents, the sweet-bay *(M. virginiana)* and the umbrella magnolia *(M. tripetala),* in flower together. This, like most later hybrids involving *M. virginiana,* was sterile and did not produce a second generation of seedlings. But Soulange-Bodin's famous introduction, in 1826, of *M.* x *soulangiana* was soon followed by additional cultivars combining its Asiatic parents, the tetraploid *M. liliflora* with the hexaploid Yulan magnolia *(M. denudata).* Some of these were probably fertile backcrosses. The same cross which produced *M.* x *soulangiana* may have occurred earlier in Japanese gardens.

In the 1930's Oliver M. Freeman, then with our National Arboretum, found *M. virginiana* cross-fertile with *M. grandiflora.* The range and flowering season of these species overlap in the wild, and insects have probably crossed *M. virginiana* var. *australis,* which is the southern, partially evergreen variety of the sweet-bay, with *M. grandiflora* many times. A number of cultivars credited to *M. grandiflora,* as far back as 'Exmouth' (cultivated since the 1730's), may actually be introgressed with *M. virginiana.* The hexaploid *M. grandiflora* is generally dominant over the diploid *M. virginiana,* so that unpedigreed hybrids were difficult to discern. 'Charles Dickens', a fertile tetraploid usually attributed to *M. grandiflora,* may be partly big-leaf magnolia *(M. macrophylla).*

The table on page 76 indicates that

ome rather wide combinations within each of the subgenera are possible. However, attempted hybrids across the subgeneric barrier, or with other genera in he same family, such as tulip-tree *(Liriodendron)*, are not recommended.

Some Suggested Parents

Aims in current magnolia breeding include: hardier plants and flower buds, particularly in the early spring-flowering group of Subgenus Yulania; larger, more colorful flowers on hardy plants; plants of smaller stature, quick to reach flowering age; flowering over a long season, or recurring bloom. There is also room for magnolias which grow into large-flowerng shade trees, but the smaller ones will be more popular in home landscapes.

With the above aims in mind, some of the most promising parents in Subgenus Yulania would be *M. stellata* and its fertile hybrids for hardiness and small stature; *M. liliflora* for dark color, reflowering and small stature; *M. dawsoniana* 'Chyverton' for large red flowers on a relatively hardy tree; *M. sprengeri* 'Diva' for large pink flowers and relative hardiness; and *M. cordata (acuminata* var. *subcordata)*, in its commonly encountered clone, for yellow color, reflowering and hardiness.

Brooklyn Botanic Garden's 'Evamaria', which is as yet unavailable to home gardeners, and other hardy *M.* x *brooklynensis* hybrids that are fertile should give interesting crosses with *M. cordata*, which has the same tetraploid chromosome level. *M. stellata*, a diploid which has given viable crosses with *M. denudata*, probably will hybridize with some other more colorful hexaploids, such as *M. dawsoniana* and *M. sprengeri* 'Diva', to give new intersectional hybrids. *Magnolia* 'Norman Gould', according to *Hilliers' Manual of Trees & Shrubs* (1972), is "reputedly a . . . polyploidal form of *M. stellata*. . ." If so, this might give fertile crosses with tetraploid species and *M.* x *brooklynensis*.

In Subgenus Magnolia, the variable *M. virginiana* has already given hybrids with species in three other sections; it is promising for both intraspecific and interspecific breeding. *M. grandiflora*, at this stage, seems more in need of clonal selection and propagation than of further breeding. However, the evergreen habit would be a valuable attribute in some crosses. For a review of its cultivars see my article in *Broad-leaved Evergreens*, revised B.B.G. Handbook No. 22, (PLANTS & GARDENS, Vol. 29, No. 3, Autumn, 1973), pp. 18-21.

The precocious *M. ashei*, from Florida, has been crossed with the larger and more northward ranging *M. macrophylla*, and such hybrids may have better garden value for some regions than either parent. The table will suggest other species to use in breeding.

Breeding Tips for the Beginner

In magnolia breeding, emasculation of buds is unnecessary. Individual magnolia flowers do not self-fertilize because they are protogynous (receptive before they shed pollen), and with some species and clones, self-fertilization of a tree or clone is absent or very rare. Flowers of magnolias in the table numbered 3, 4, 6a, 17, 19, 21, 26, 27, and the majority of clones in 22 and 23 are thought to be self-sterile. Most others appear to be self-fertile and will need more thorough covering to insure that they are not pollinated by older flowers on the same tree. A regular practice is to place a brown paper bag over each unopened flower you intend to hand-pollinate, so as to exclude beetles and other insects that could bring in unknown pollen.

Stigmas in Subgenus Magnolia are receptive to pollen only immediately before or on the day the flower first opens. For Subgenus Yulania, the timing is often less clear-cut, but you can examine the stigmas on buds near opening, to see if they are spread out from the gynoecium ("cone"), which indicates the receptive condition.

Pollen is best collected from cut flowers allowed to open indoors. After the stigmas have returned to a more vertical position, the anthers may be removed and spread in a shallow glass dish (lid off)

30 MAGNOLIA SPECIES IN AMERICAN CULTIVATION

(Numbers in parentheses show species with which they have been crossed, one way or both.)

SUBGENUS MAGNOLIA

Diploids (2n-38)
(American):
1. *ashei* (2)
2. *macrophylla* (1, 6)
3. *fraseri* (5?, 6 x 15)
4. *pyramidata*
5. *tripetala* (3?, 6, 6 x 6a, 12)
6. *virginiana* (2, 5, 7, 12, 14, 15)
6a. *virginiana* var. *australis* (6, 15)
(Asiatic):
7. *globosa* (6, 10)
8. *sieboldii* (12, 5)
9. *sinensis* (10)
10. *wilsonii* (7, 9)
11. *rostrata*
12. *hypoleuca (obovata)* (5, 6, 8)
13. *officinalis* var. *biloba* (5?)

Tetraploid (American) (2n-76)
14. *grandiflora* (?) 'Charles Dickens' (6, 15, 6 x 15)

Hexaploids (American and Mexican) (2n-114)
15. *grandiflora* (generally) (2?, 6, 6a, 14)
16. *schiediana*

SUBGENUS YULANIA

Diploids
(Asiatic):
17. *cylindrica* (27?) (We have probably only the hybrids of this.)
18. *kobus* (19, 20, 27)
19. *salicifolia* (18, 20)
20. *stellata* (18, 19, 21, 27)

Tetraploids
(Asiatic):
21. *liliflora* (20, 27, 27 x 24, 29)
(American):
22. *acuminata* (21, 23, 27)
23. *cordata* (22)

Hexaploids
(Asiatic):
24. *campbellii* (25, 27)
25. *campbellii* ssp. *mollicomata* (24)
26. *dawsoniana* (28)
27. *denudata* (18, 20, 22, 24, 17?)
28. *sargentiana* var. *robusta* (26, 29)
29. *sprengeri* 'Diva' (21, 27, 28, 21 x 27)
30. *sprengeri* var. *elongata*

SOME CULTIVATED HYBRIDS

Hybrid	*Parentage*	*Remarks*
M. x *brooklynensis*	(22 x 21)	Part are fertile; 'Evamaria' and 'Woodsman' have been named.
M. x *kewensis*	(18 x 19)	Seedlings unnamed, except for 'Wada's Memory', previously under #18.
M. x *loebneri*	(18 x 20)	Several named to date; vary in stature, petal number and fragrance; 'Leonard Messel' is pink.
M. x *proctoriana*	(19 x 20)	Unnamed
M. x *soulangiana*	(21 x 27)	Many cultivars and back-crosses named.
M. x *thompsoniana*	(6 x 5)	Two or more cultivars; *M. virginiana* is the female parent in all known cases.
M. x *veitchii*	(27 x 24)	Two cultivars and back-crosses.
M. x *watsonii*	(8 x 12)	One cultivar? Mostly sterile, but has pollinated #5.
"Freeman Hybrids"	(6 x 15)	Two named selections so far; less fertile than the parents.
"Little Girls"	(21 x 20)	Eight or more named; sterile triploids.
'Caerhays Belle'	(28 x 29)	Less hardy than #29.
'Charles Coates'	(8 x 5)	Hardier than #8.
'Orchid'	(20 x 21)	Brighter flowers than *M. liliflora;* sterile?

Gordon DeWolf

Magnolia x *loebneri* 'Merrill'

to dry and shed their pollen. It can be used as soon as visible, if there are suitable flowers to be pollinated, or dried and refrigerated in a stoppered vial or 35mm. film can for future use. Dried pollen (in cans with desiccant capsules) can be mailed long distances and refrigerated upon arrival. (See page 13.)

In some crosses the seeds, or most of them, can be apomictic, reproducing only the seed parent. Certain trees in *M. virginiana* seem more apomictic than others. *M. acuminata* also sometimes gives apomictic seeds after pollination by other species, but if enough crosses are made in a compatible combination, some interspecific hybrids may be expected.

M. x *soulangiana* cultivars vary in fertility. Good seed producers include 'Lennei', 'Grace McDade', 'Picture' and 'Rustica Rubra'. Several hybrids have been made with 'Lennei Alba' as one parent. All these are probably easier to hybridize than the parents, *M. denudata* and *M. liliflora.*

Some species, *M. acuminata* particularly, can have very young fruits destroyed by blackbirds. These should have a protective cover from an early stage. All species need fruit covering to keep birds and squirrels from collecting partially ripe seeds ahead of the breeder.

All magnolia species have seeds that lose viability if fully dried. Moist cold storage of seeds, followed by spring planting in a place safe from rodents, is recommended. Some species take many years to grow to flowering size; a skilled grafter can save time by top-working scions from seedlings to limbs of flowering-age trees of graft-compatible understocks. Some lines of *M. virginiana,* however, give seedlings that flower within three or four years; *M. ashei* is another that can flower at an early age. In general, growth is faster and flowering occurs sooner in warm-temperate climates, but amateurs can breed magnolias wherever some of the species ripen seeds regularly. ⁂

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BROOKLYN BOTANIC GARDEN RECORD
PLANTS & GARDENS

A HANDBOOK ON ANNUALS

- Landscape Uses for Annuals
- Dictionary of Favorite Annuals
- Growing Annuals in Pots, Boxes & Other Containers
- Regional Tips

Vol. 30 No. 2
(Summer 1974)

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BROOKLYN BOTANIC GARDEN RECORD
PLANTS & GARDENS

HANDBOOK ON ANNUALS

Vol. 30 Summer (August) 1974 No. 2

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Roberta Moffitt

George Taloumis

ANNUALS AS CUT FLOWERS

Annuals are long-lasting and colorful subjects for indoor flower arrangements. The arrangement above by Roberta Moffitt features zinnias, marigolds, celosia, larkspur and a few flowers of the perennial day-lily. Sweet peas (*left*) are grown almost solely for cutting

LETTER FROM THE BROOKLYN BOTANIC GARDEN

Annuals have had a resurgence of popularity in recent years, and it is easy to undertand why. No other group of plants provides as long a period of bright color in the arden. Relative ease of care, quick effect, and diversity of floral hue, height and texture re other factors contributing to their appeal. The unique nature of annuals, which do heir botanical "thing" in just one growing season, is particularly attractive to gardeners vho like to try something new each year (and not enter bankruptcy in the process).

For the new gardener annuals can be a valuable introduction to the world of plants, nd if a few mistakes are made the first year—the occasional group of tall plants in front f lower-growing ones, or red salvia sizzling next to pinkish-purple petunias—they don't aunt one forever, or at least not in the same way as does the misplacement of trees and hrubs in landscape. Each spring there is a new opportunity, and the experience of the revious year makes the garden (and gardener) a better one.

Seasoned growers have a lot to learn from annuals, too. There are enough different inds to choose from for a lifetime of pleasurable experiment. For gardeners who object o the neon intensity of some of the better-known annuals, there are a surprising number vith soft hues or refined texture. As our Contributors point out, there is a place for nnuals in just about every home landscape.

Let us at this time express our warmest appreciation to Guest Editor Joseph M. Lent and he 11 other Contributors he has invited to share their knowledge with us. We would articularly direct your attention to Derek Fell's dictionary of annuals, beginning on page 9. Mr. Fell oversees the All-America Selections, a seed-trade organization that has served ince 1933 as a clearinghouse of information about noteworthy new annuals (and egetables, too). Among its cooperating members, AAS has 30 flower trial gardens in North merica. This enables new varieties, of which there are many each year, to be properly valuated by horticultural experts on a wide geographical basis. Each year's winning elections represent the best of the current "crop," and the home gardener may be assured f a high level of quality in such winners.

Perhaps a word or three about the annual that is clearly the most appealing (or ppalling) one of all to visitors at the Brooklyn Botanic Garden. It is Amaranthus 'Early plendor', a striking foliage plant with the upper leaves bright red and the lower ones eep purple. Because the grass strip separating the B.B.G. annual border from the viewing ath is usually worn away by people stopping for a closer look at 'Early Splendor', it has ecome necessary to plant this electric tropical behind a cement bench placed in the turf. Early Splendor' is not for every garden because of its vivid color and substantial height often 4 feet), but it has a place in a large garden or where it can be given a specimen ocation. See the color insert of this Handbook for a photograph.

May this Handbook on Annuals increase your knowledge and pleasure in growing a vonderful group of plants.

Frederick McGourty, Jr.
Editor

COLOR YOUR GARDEN WITH ANNUALS

Planting and growing annuals has never been easier or more satisfying

Corinne W. Willard

HOMEOWNERS, as well as city gardeners using balconies or rooftops, have a wide choice of these colorful plants. The "big four" in annuals—marigold, petunia, snapdragon and zinnia—are the most important for season-long color and garden interest in many parts of the United States. Of course, gardeners everywhere have personal favorites, including calendula, cleome, cosmos and dahlia in their numerous cultivated varieties. Today, with more and more people gardening in confined spaces, window boxes and hanging baskets are especially popular. Many kinds of plants, among them various herbs and vegetables, can be successfully grown in them, but it is annuals we usually turn to for a bright, colorful display.

Breeding Accomplishments

Plant breeders have manipulated the genes of annuals with astonishing results, transforming the original species through hybridization and selection to cultivated varieties that resemble the wild kin only slightly. The gardener now has choices not possible even a few years ago: annuals flowering on very young plants for a long season of bloom; compact plants needing a minimum of attention; distinctive growth habits, including dwarf or trailing forms. Some annuals with a typically short flowering season, verbena for example, have been bred for longer bloom. Others, among them portulaca and nicotiana (flowering tobacco), responding in different ways to sunlight, now have flowers open for a longer period each day. There are new nasturtiums with blossoms held above the foliage for greater garden effect. There is work still to be done, but each year sees improvements, including greater insect-and-disease resistance.

How to Start the Season

A common way to begin the new gardening year is to purchase young plants from a garden supply center or nursery in spring, after danger of frost is past, and set them directly in the garden. Another method is to grow your own annuals from seed, started indoors in late winter or sown in the garden in spring, if the growing season in your area is long and the chance of greater loss does not discourage you. Both procedures, the purchase of young plants and the growing of seeds at home, have advantages and disadvantages.

In recent years, a multi-million dollar horticultural industry has come about, producing annuals and other bedding plants in pots and trays, which are miniature flats containing a number of seedlings. Using factory-sized greenhouses and precise, uniform growing methods based largely on research by the U.S. Department of Agriculture and experiment stations around the country, wholesale growers offer garden supply centers compact, sturdy plants which are then made available to home gardeners. They are usually excellent because every stage of their growth has been carefully controlled. Often, too, the plants are in bloom at the time of purchase, an advantage to gardeners who, for example, like to see the flower of a petunia before incorporating it in a planned or existing color scheme.

Such annuals which are sold in trays are usually well-labeled, with a brief description, cultural advice and suggestion on planting distance. They are time

Paul F. Frese

Drury

There is so much variation in the size of marigold flowers and in the height of the plants that entire borders featuring marigold plants alone are possible. The border above contains tall, large-flowered African-type marigolds and low, compact French varieties in the foreground.

Right: Garden centers and nurseries offer compact, sturdy seedlings of most annuals, such as marigolds, shown at right, in lightweight handy trays, ready to plant.

savers for the busy gardener. Losses in transplanting are small because of the plants' well-established root systems. (See photographs below for information on how to plant annuals from trays.)

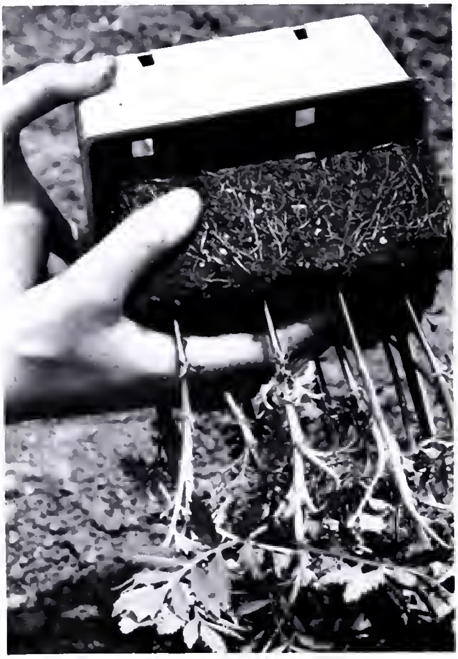
Growing Annuals from Seed

In every group of gardeners there are those who say "But Mother, I'd rather do it myself." Beginning in January, remembering what was enjoyed in the garden last summer, we read the new mail-order catalogs and order certain annuals we want to grow from seed. Here we have an advantage: large commercial plant-growers necessarily concentrate on the kinds of annuals most likely to sell—they cannot afford to produce ones with lower sales potential. However, a wide variety of choice, uncommon or special-purpose annuals, available from catalog firms or garden supply centers, can adorn the garden if time and care is taken to start them from seed in the home. Most seeds in a packet will germinate, and one of the pleasures of this form of gardening is to swap surplus young plants with a friend who has started something else from seed.

Generally, annuals with small seeds require a longer growth period indoors to produce a flowering plant in the garden than do ones with large seeds. Even so, unless a small home greenhouse or other excellent light source is available, it is unwise for gardeners in the northern tier of states to start most seedlings indoors much before March. Begin them at least eight weeks before planting outdoors; twelve weeks are better for types with small seeds.

The excitement of starting my own plants leads me to do it with some annuals each year. I use fluorescent light stands, combining one cool-white and one red flourescent tube in each fixture. The

PLANTING MARIGOLD SEEDLINGS



Rather than removing one plant at a time, remove all plants at once by turning flat upside down.

Then use a trowel or knife to cut the see
lings apart and start planting immediately,
use newspaper to prevent roots from dryin

planting room in our house is kept at 68°F., with fourteen hours of light provided each day.

The new fine-graded mixture of peat moss and vermiculite, available at most garden supply stores, is very satisfactory for starting seeds. I use a carefully cleaned or new plastic plant tray which is filled *nearly full* with the mixture. Avoid touching the mixture more than necessary. Mark the plant label now with sowing date and name of the annual.

It is difficult to see small seeds against this mixture, so consider how best to distribute them in the tray. Evenly planted trays are not only more pleasant to contemplate after germination, but they are more likely to produce good seedlings. Uneven planted trays result in crowded seedlings which soon become leggy; they are also more susceptible to damping-off disease.

Put the tiny seeds in your left palm, then take a few of them between the thumb and forefinger of your right hand, and plant a section of the tray with each pinch. Remember exactly where you have placed seeds of the first pinch before doing the second and third. Another way to make sure one end of the tray is not overplanted and the other underplanted is to divide the tray in half, and the seed quantity in half, distributing seed evenly for the space.

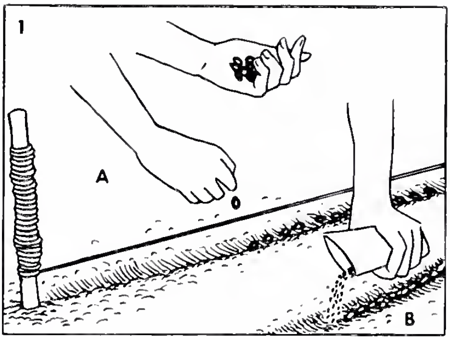
Gardeners develop favorite ways for covering newly planted seeds. Remember that Mother Nature barely covers seed in the wild. Tiny seed usually settles between the particles of the peat-vermiculite mixture, especially when watered after planting with a fine mist from an atomizer or from a rubber squeeze-bulb. The plant label should now be in the corner of the tray.

Allow excess moisture to drain from the watered tray, then place the tray in a

Prepare a hole large enough for each plant. Marigolds, like tomatoes, can be set deeper than original depth for firmer foundation.

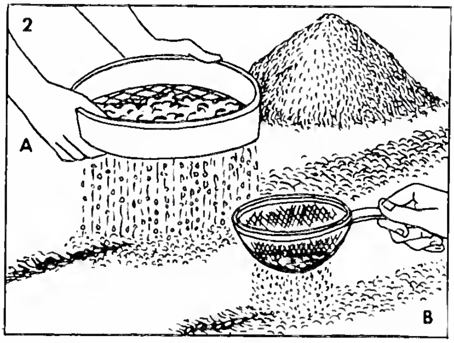
Press soil around roots and then apply a thorough soaking. Mulching reduces need for later watering during drought.

Step-By-Step Directions for Seed Sowing in the Garden

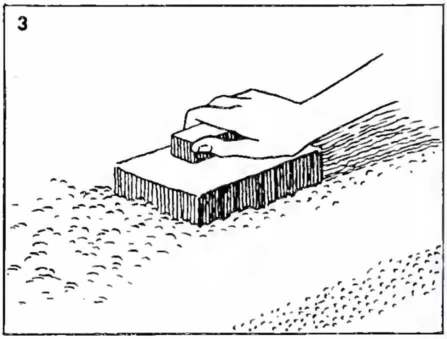


1 Fork and rake soil before sowing seeds. A "rule of thumb" for sowing depth is three times as deep as the seed is large. Large seeds can be sown one-by-one (A); smaller seeds dribbled carefully from envelope (B).

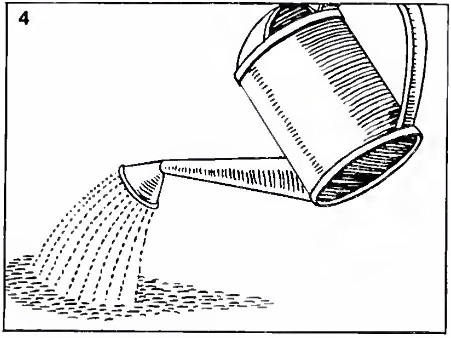
Eva Melady



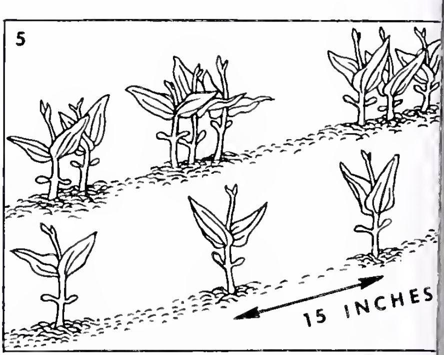
2 Rather than sowing seeds in furrows as above, the seeds can be spread or "broadcast" on prepared seedbed. Large seeds can be covered by soil sifted through coarse sieve (A) and smaller seeds by fine sieve (B).



3 After sowing and covering seeds, soil can be evenly firmed by the use of a tamper, which can be constructed for this purpose from two blocks of wood, as shown above.



4 After the soil has been tamped, a thorough but gentle watering should be applied. Use care so the soil is not washed and seeds disturbed or left uncovered. Continue to water as necessary.



5 Seedlings can be transplanted as soon a the true leaves have developed. Space large flowered zinnias (*shown above*) about 1 inches apart. Most seed packets give sug gested spacings for transplanting.

lear, clean plastic bag and loosely close ne open end of the bag. Seedling trays hould be placed about 4 inches below ne light source if fluorescent lights are sed. Most of the commonly grown anuals are not particular about light or arkness for germination, but they need ood light as soon as seedlings emerge.

A sheet of household plastic long nough to hang down the sides of the ray is sufficient cover during germinaion. Either way—plastic bag or sheet—ou will not need to water the tray durng the germination of most annuals. void excess water during the whole eedling procedure.

Care of New Seedlings

hen comes the excitement of the emergng seedlings. The miracle of germination as taken place again. You should remove he plastic bag or sheet when about one-enth of the expected seedlings show, not hen the first two or three emerge. Mark he label with the germination date.

From now on, watch seedlings for clues bout their needs. If they become leggy hey may require more light. Be alert to ilting, for tiny seedlings can be lost in short time if moisture is too low. Again, owever, do not over-water—it encourges disease and increases the possibility or leggy growth.

When seedlings emerge, the most danerous time has arrived. Damping-off, a isease caused by one or several fungi, ometimes attacks the tender seedling at he soil level, and kills cells in the tissues f the stem, causing the seedling to tople over. The seedling is still green at the op but is doomed because water-conductng tissues have been destroyed. The disase spreads rapidly through the tray if onditions are right, so you should have n hand a recommended fungicide to ix with water for drenching the tray.

Sometimes damping-off attacks germiating seedlings before they emerge hrough the surface of the planting mixure. Gardeners tend to blame the seed, ut more often it is the disease that reults in a poor stand of seedlings. Use of a pasteurized medium, such as the fine-graded mixture of peat moss and vermiculite, greatly reduces the possibility of damping-off. Every day that passes increases resistance to damping-off, if it is to be encountered at all, so you soon know how many seedlings for which you will have to provide transplanting mixture, trays or pots, and space.

An Intermediate Step

I usually transplant seedlings to another tray or pot when they have two sets of true leaves (salvia, opposite leaves), or two-three true leaves (petunia, alternate leaves). If a prepared potting soil is used for transplanting, add vermiculite, perlite (my preference) or sand, perhaps ¼-⅓ by quantity, to lighten the soil mixture. Holes should be made in the transplanting tray mixture for the number of seedlings you wish to plant there, usually six to nine. Using the label, I loosen the mixture around the roots of several seedlings in a group, grasp a seedling by a leaf and gently work the root system out of the group, still using the label. The seedling is then planted immediately into the prepared tray or pot. Remember to mark the label with the transplanting date, for your records, and place it in the new tray or pot. Prepare separate labels for each tray or pot of transplanted seedlings.

Use a diluted soluble fertilizer for the initial watering. Leave seedlings in a dark place overnight, and if you don't have an artificial light system, put them in your brightest room the next day. Watch for wilting, also for signs of too much sunlight too soon, which is possible in a southern window. The leaves may burn or become very pale because of imbalance of light, water and temperature. Seedling roots need time to adjust to the transplanting mixture, and the tops of the young plants may be reflecting the struggles of the roots.

Ideally you should have a good enough light source so that plants need not be turned to encourage even growth. I try to place a transplanted seedling so the upper leaf surface is about 8 inches from

George Taloumis

A window box of different varieties of coleus and the trailing zebrina. Such a grouping is especially suitable for city conditions in partial shade. Plants can be kept over winter in a well-lighted window and increased by cuttings in February.

the fluorescent lights. If a sunny window is used for growing your seedlings instead, occasionally turn the pots or trays to offset the seedlings' tendency to lean toward the stronger light. Usually you won't need to pinch these young plants. Most of today's annuals have been hybridized to produce branching plants.

As soon as possible, I move transplanted seedlings outdoors to a side porch. This exposes them to breezes as well as to good, all-around sunlight. The plants become sturdier and more compact. They must still be brought inside at night until mid-May in our part of Connecticut because of late frosts. If there is room in the coldframes, I place the annual seedlings there for at least the last two weeks of growth before planting in the garden. Sturdy, well-hardened plants result.

Guidelines

When you plant annuals, whether from the garden supply store or from your own seedling trays or pots, there are a few guidelines for success:

By nature, annuals grow and complete their life cycle in one season. Therefore most of them require good sunlight for best results. If full sunlight is not available, several hours of direct sunlight wil do well for many annuals. See page 22 for moderately shade-tolerant kinds. N annuals can be expected to thrive in ver deep shade.

Most annuals grow well in many kind of soil. This is one reason for their popularity. However, as with most plants good drainage is essential.

Planting distance between annual should be considered before planting. I you've grown your own, you probabl have already considered how many yo need for the space. Commercially-grow plants often have labels with each tra which give dimensions of plants and suggested planting distances, and most see packets have similar information.

Methods of rooting coleus cutings: Shoots will readily root in water and can then be potted, or they can be inserted in pot containing sand or any rooting medium available.

Roche

Plants grown in peat pots may be planted pots and all. However, first peel down the shoulder of the peat pot far enough so the pot doesn't show above ground. The peat acts as a wick, drawing moisture from the root area into the air, which can result in a damaged or dead seedling.

If a purchased plant is in a fiber or plastic pot, remove the pot before plantng, taking care to damage as few roots as possible.

Use a liquid transplanting hormone or soluble fertilizer to water plants into the garden soil. I usually try to plant between 4:00 p.m. and dusk, to give seedlings a dark period to begin adjusting to the new situation. Sometimes, on a bright day folowing planting, I cover annuals with berry baskets or newspaper tents between 10:00 a.m. and 2:00 p.m. If transplantng can be done the day before a cloudy day, do it.

Once the plants are growing on their own, garden jobs are less pressing. Weeds are a problem until the plants fill their niches, but don't let them get ahead of you. (See page 12 for mulching tips.)

Finally, a note about annuals in winter. You may have grown favorite ones as house plants during the cold months. Coleus, impatience and wax begonias do well in a sunny window. It is a good way to carry over especially pleasing colors or forms which you grew outdoors last summer.

In February begin taking tip cuttings of these plants to start new ones for the summer garden. Using a 50-50 mixture of peat moss with sand, vermiculite or perlite (or other material if you have had success with it), place the cuttings in the mixture and cover with a sheet of plastic as described for seedling trays. Put them in subdued light. I have used straight perlite and, following the rooting period, have held cuttings in good condition for several weeks before potting. Cuttings may be taken from the original stock again in April for additional plants. ☘

Fertilizing, mulching, staking and deadheading . . .

SUMMER MAINTENANCE FOR ANNUALS

Edmond O. Moulin

Most annuals grown in the flower border are not very demanding about nutrients, but a little care given to fertilizing will often bring improved performance. Frequency of application depends on the nature of the soil, rainfall and length of growing season. The following method seems to work well at the Brooklyn Botanic Garden, where the soil in the annual borders is a clayey loam, the texture of which has been improved over the years by generous incorporation of compost, peat moss, manure and other organic materials. Our borders serve double duty, hosting annuals during the four warmest months of the year and tulips the remainder. Rainfall averages 43 inches a year, but no two years are the same.

In spring, before planting, a 5-10-5 granular fertilizer is applied to the soil (*rate:* 5 lbs. per 100 square feet) and raked in. About three times a summer, more often if the season is unusually wet, a soluble fertilizer is applied to the soil. There is less chance of burning the plants with it than with a granular type, and it goes to work at once. In either case it is important that the soil be moist before fertilizing. However, before applying granular fertilizer be sure the foliage is dry. Heavy rains can leach both kinds from the soil quickly.

The plants usually tell us when it is time to fertilize. Petunias are a good indicator. If they are growing in full sun and have been receiving ample water, as they should be, and foliage becomes spindly, with traces of yellow appearing on the lower leaves, a nitrogen deficiency is likely. Out comes the soluble fertilizer with a high-nitrogen content. We use a hose applicator, but in the small home garden a watering can will suffice.

A completely new border may require double digging if the soil is poor. (See the Handbook on Soils, No. 20 in the B.B.G. series.) It is wise in any case to have a thorough soil test made periodically, as well as a pH test. Ask your county agent where a soil sample may be sent in your state. Follow the specific recommendations given by the authority, usually the state university, for improving the elements in your soil and for correcting the pH (acidity level). If phosphorus, a key element in flowering, is deficient, work superphosphate into the soil to a good depth, since surface applications penetrate only the top 2 or 3 inches of the soil in the course of a year.

Soluble fertilizers with the major elements (nitrogen, phosphorus and potassium), used at the rate recommended on the package, are compatible in the hose sprayer with pesticides, also used at the recommended rate. (Don't use the latte on amaranthus or alternanthera.) Thi can be a labor saver if both are neede at the same time. Fertilizers with micr elements, if required at all, should be ap plied separately.

Mulches for Annuals

Like most other plants, annuals in th flower border benefit from a 2- or 3-inc layer of mulch. It retains moisture in th soil, cuts down on weeding, and eventually improves soil texture. Plants grow better and require less watering. Buckwhea hulls, cocoa bean shells mixed with sawdust for better porosity, sawdust, pea moss (but see page 13), shredded leave or any similar material that is easy t obtain may be used. However, woo chips, pine bark and other coarse, slow-to-decompose mulches aren't good choic for the annual border because they mak planting more difficult in succeedir springs. Even black plastic can be use

Cleome is one of the tall-growing annuals that usually does not require staking.

Paul F. Frese

with holes cut in it for the plants and slits made so rain can penetrate. For a better appearance, add a thin layer of organic mulch on top of the plastic.

The new chunk-type peat moss is a satisfactory mulch too, but the more common Canadian or German peat moss is not recommended because it becomes virtually impermeable upon drying. If regular peat moss is the only material at hand, split open a couple of bales in autumn and keep them in an inconspicuous spot in the yard over winter. The weathering action will thoroughly moisten the otherwise difficult-to-wet peat moss. Even then, never let peat moss dry out when used as a mulch. It is essentially a soil conditioner and is fine for incorporating in the soil to improve texture before planting time.

Before planting, the border should be thoroughly weeded, since mulches are effective in keeping annual weeds from emerging. Established weeds often flourish in the mulch if not first removed. Apply the mulch immediately upon planting and watering your new ornamentals, unless the border contains pesky perennial weeds such as quack grass or mugwort. In this case, delay mulching until a month after planting, since this provides another chance to rogue persistent undesirables missed during the earlier cultivation. Keep the mulch an inch or two away from the base of annuals to cut down on stem rot. If you use sawdust or other mulch that has already begun to decompose, add a few extra handfuls of high-nitrogen fertilizer to compensate for temporary nitrogen loss from decomposition.

In autumn, after removing dead annuals, work the remaining mulch into the soil. It will gradually decompose and improve the soil texture for succeeding years. This is "organic" gardening at its best.

Staking

Many tall-growing annuals require staking to look well through summer. Among them are the more robust sorts of marigold, snapdragon and zinnia. Cosmos and larkspur usually need it, too. Cleome and nicotiana may or may not, depending on the weather. To avoid staking,

Eva Melady

When removing fading petunia flowers, be sure to pinch off new-formed seed head.

which can be time-consuming if a number of plants are involved, grow the most compact forms of an annual that are available. For example, calendula selections 'Golden Gem', 'Orange Gem' and 'Dwarf Sunny Boy' are not quite as leggy as other calendulas and probably won't require this extra gardening step. If long flower spikes on snapdragons are wanted for bouquets, be resigned to staking, but if you are mainly interested in growing these plants for garden beauty, the dwarf Floral Carpet strain, which comes in several colors, will be satisfactory.

You risk a poke in the eye if stakes are put in the ground simultaneously with young seedlings. Best wait awhile, but not until plants flop over from wind or rain. Nothing in the garden is a sadder sight than downtrodden plants scooped together and tied like a mop. Select stakes that are as inconspicuous as possible—it's the flowers you want to see, not pieces of wood. Generally, they should be about 2½ feet long, with the bottom 6 inches set firmly in the soil. Use a coarse grade twine to tie plants to them.

There are a couple of ways to cut down on staking and to form compact, multistemmed plants of annuals that become leggy. Pinch the tips of tall-growing marigolds and snapdragons at planting time, then again two weeks later. This is also beneficial with amaranthus and cosmos. Close planting sometimes helps, too. Although some gardeners do it with success, slightly deeper planting of tall annuals can result in stem rot if soil is wet and heavy. Best advice—choose low-growing kinds if tall ones aren't essential for garden effect.

Deadheading

The removal of faded flowers—deadheading, as it is known to gardeners—is a desirable practice with most annuals and many other plants. It gives the garden a tidier appearance and, more important, conserves plant energy for greater flower production, since seed formation is prevented by a pinch of the fingers. Some plants, among them geranium and petunia, require more deadheading than others to continue looking well. In the case of the geranium, removing the old flower cluster also discourages botrytis, a rapidly spreading fungus disease. With petunia, be sure to remove the new formed seed head at the bottom of the spent blossom.

If petunia, verbena, sweet-alyssum and nicotiana become straggly by midsummer, do not hesitate to use the hedge or grass shears or pruning clippers on them. Remove up to one-third of the top growth. After the "haircut," water the plants well and apply a soluble fertilizer

A few annuals don't require deadheading to look well or to continue good flowering. Most notable are impatience wax begonia and annual vinca or periwinkle. Many of the taller-growing zinnias, some marigolds and annual blue salvia produce strong top growth and new flowers which obscure the faded blossoms, so deadheading is unnecessary with them. However, pinch off the spen flowers of the more dainty or compac zinnias and marigolds. ☘

Annuals are more trouble-free than are most plants

INSECT AND DISEASE CONTROL

Joseph M. Lent

In general, annuals are not troubled with as many insects and diseases as are other flowers. Their short life is partly responsible for this. Modern plant breeding has brought forth disease-resistant strains, such as rust-resistant China-asters and snapdragons. Wilt-resistant strains have also been developed. Seed companies promote these varieties and list them as such in their catalogs.

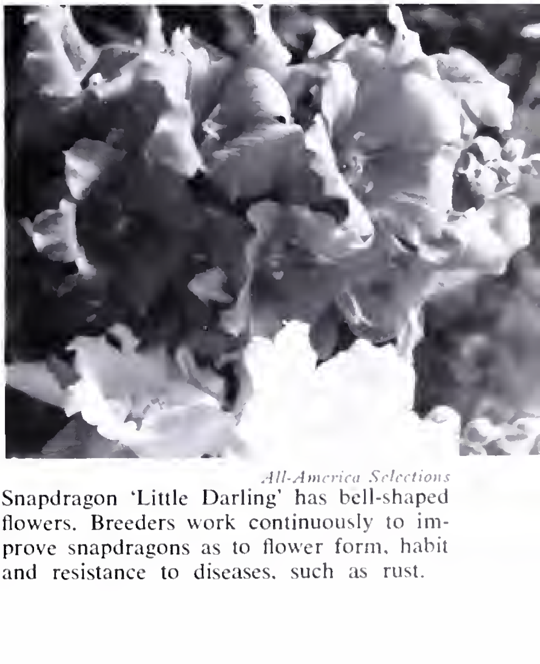
Damping-off, leaf spot and powdery mildew are often found on annuals, particularly during wet and humid weather. Diseases can be avoided to a large extent by good sanitation practices, by proper spacing of plants and by avoiding over-watering and unnecessary wetting of the foliage.

Among insect pests, probably the aphid is the most prevalent but others, such as leafhoppers, white flies, Asiatic garden beetles, Japanese beetles, cutworms and spider mites, are also troublesome. Limited infestations of beetles can sometimes be controlled by hand picking. Aphids can be washed off by a stream of water. It is possible to control cutworms if paper collars are used around the plant stems.

Weather and climate are usually the most important factors that influence disease and insect problems. When the environment is ideal for the propagation of plant pests, only chemical remedies can control them. A preventive spray or dust program, in our experience, is the most satisfactory approach for their treatment.

General-purpose pesticide mixtures are available at most garden and hardware stores. These all-purpose mixtures can be purchased as dusts, wettable powders or liquid concentrates. Dusts are the most convenient to use in small gardens but are easily washed off by rains and must be applied more often than sprays. An all-purpose pesticide should contain at least two of the following insecticides: carbaryl (Sevin), malathion or methoxychlor; as well as one or more of the following fungicides: captan, ferbam or zineb. For powdery mildew, use sulphur, benomyl or karathane. Before purchasing, the label should be carefully read to make certain the proper chemicals are present, as well as to determine the diseases and insects the contents are intended to control. Precautions, dilutions, frequency and method of application should be carefully observed and followed.

Under cool wet conditions, garden slugs and snails can be a problem. Clean cultivation will help reduce the infestation. Hand picking at night may be practical, using a flashlight and an old spoon. Heavy infestations are best controlled by using commercial preparations containing measurol. ☘



All-America Selections

Snapdragon 'Little Darling' has bell-shaped flowers. Breeders work continuously to improve snapdragons as to flower form, habit and resistance to diseases, such as rust.

A landscape architect's view of the role of annuals in gardens public and private

ANNUALS IN THE LANDSCAPE

Rudy J. Favretti

The use of annuals is often given short shrift in the landscape field. Designers are apt to pass them over as too difficult to obtain, temporary in effect, or secondary to the total plan. However, home landscapes are frequently the loser when annuals are not employed.

A common excuse for excluding annuals is that perennials are considered easier but, having grown both intensively, I can assure you that they require the same amount of care. The gardener who says that perennials are more readily grown has likely neither divided matted clumps of Japanese iris and hemerocallis, staked delphinium and globe-thistle (*Echinops*), nor carefully tended perennials through the entire year. As new homeowners soon learn, there is no such thing as armchair gardening.

I derive equal pleasure from growing annuals and perennials, but there are a few effects that annuals seem to achieve more quickly and with greater impact. And if the gardener doesn't like their final garden effects, he doesn't have to wait several years to find out. A hard frost at the end of the season will turn the page to another year.

Defining Space

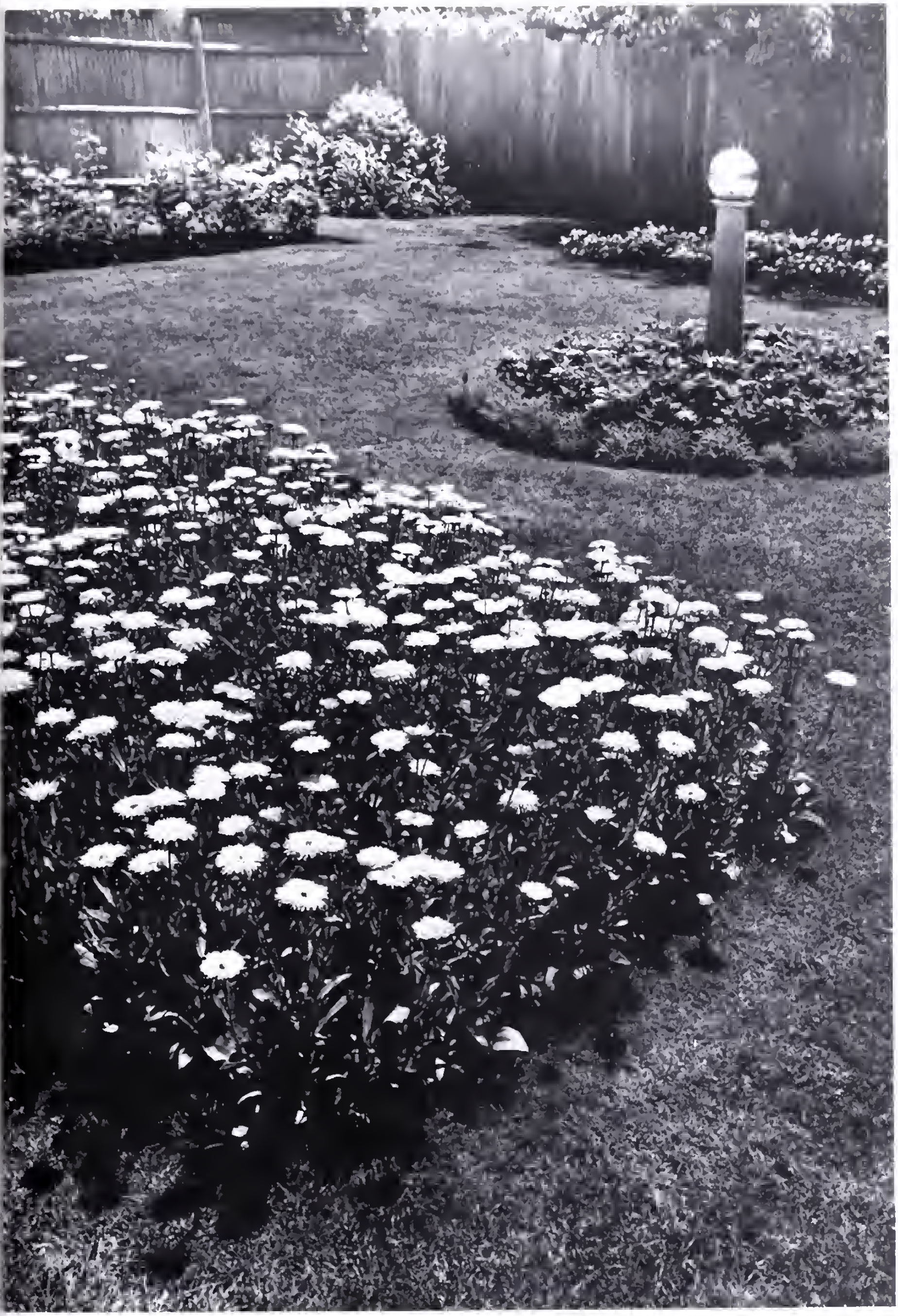
Annuals are wonderful for defining a space and saying, "Here is the edge of a patio" or "Stay within this walk." I vividly recall a landscape effect I once saw on Isola Madre in Lake Maggiore in Italy. It was a 10-foot-wide walk lined with bright orange arctotis. The flowers glistened so brilliantly that it would have been impossible to step off the walk and into the garden even if the walk had been crowded with tourists. The flowers were like hands pushing the visitor back.

Other plants may have the same effect through density of green foliage or through height, but with annuals it can be achieved through the intensity of their floral hues, and the height, by a careful choice of varieties, can be whatever the gardener desires. The flowers, in turn, can create a playful feeling if bright hues are used. At the other end of the spectrum blues and violets give a restful, cool look.

By using annuals to define a space, the property can be organized so that its divisions read clearly—the terrace for sitting, the play area for playing, and the entrance for arrival. This, to me, is what landscaping is all about, and the use of annuals is one way to strengthen the total plan.

Trees and shrubs give the backbone to landscape design. They are around all year so should be used as the basis for the plan, but annuals planted in front of a shrub border may add focus and liveliness. Because of the vast diversity of color, height, form and texture in annuals, there are many possible combinations. One grouping I like very much is a bed of tall-growing, white-flowered 'Helen Campbell' cleome against a green bank of shrubs. It gives an exotic effect. At the base, a low-growing annual, such as one of the many special varieties of marigold, petunia or salvia, takes over when the cleome is at a low point.

Annuals provide unity in the landscape if used correctly. By arranging groups of annuals as accents along a shrub border or in a perennial bed, and repeating them now and then, a great sense of continuity is created, especially in an extensive border. Neutral colors can be employed to temper clashing plantings of perennials. We often plant snapdragons —white, yellow or pink—or a blue-flowered sage, *Salvia farinacea* (usually



Patrick W. Grace

Annuals have been freely used in this formal garden. In the foreground is a massed planting of calendula 'Persimmon' and 'Lemon Beauty'. The circular bed around the gazing globe includes zinnia Peter Pan, an outstanding strain available in orange, pink, plum and scarlet.

Low-growing annuals such as sweet-alyssum are ideal for defining the edges of a path.

Paul F. Frese

treated as an annual in the North), to achieve this effect.

Various Uses

Every group of plants within the kingdom offers choices for each situation—hot and dry, moist, shady, sunny, etc. This is true of annuals, too, and a number of them are even adapted for containers. (See page 51.)

Purists among rose gardeners may dispute this next place to use annuals in the landscape, but I like the idea of planting small, delicate annuals around the base of the rose bed. The soil in rose beds is often bare and unexciting to look at, so when planted with lobelia, annual candytuft or sweet-alyssum the bed is brightened and made complete. These annuals are so small that they really do not deprive the roses of nutrients.

We even include a few flowering annuals in our herb garden. Most herbs do bloom but not conspicuously. The annuals add spots of color among the herbs and, especially in late summer after many of the herbs have been well picked over for kitchen use, they are the mainstay of the garden.

For Vacation Houses

For gardeners with summer homes, a few select annuals can enliven the grounds for the entire vacation period. This need not involve much work. Try just a clump of annuals near the door, by a rock, around the entrance walk or drive—or maybe only a container planting by the door. About the time most people go to their summer places, garden centers are trying to sell out the remainder of their stock and an interesting còmbination of material can usually be purchased at low cost.

What about the landscape "outside the garden gate?" One striking aspect of gardens throughout the world, apart from the United States, is the use of annuals in public places. Beds in parks are devoted to annuals, planters outside of buildings are commonly used, hanging baskets are placed in store fronts and on lamp posts, and tubs line the street. Such color in the landscape gives the "somebody cares" look.

Fortunately this practice is coming back in this country. It may be especially noticed in tourist regions where merchants want their places to look their best. The entrances to recreation parks, museums and other public places are also increasingly planted with annuals.

Why not start a group in your own town to spur the planting of median strips along roads, entrances to the town hall or municipal building, or perhaps to introduce annual planters along the main street? Sometimes tree planters already exist where annuals might be included at very little expense. All these steps make the community landscape a better place and more people will learn to appreciate flowers and include them in their own landscapes. ✤

George Taloumis

Above: A white picket fence is the background for a garden of many kinds of annuals, including snapdragon, ageratum, feverfew and annual phlox.

Right: A pot of petunias decorates a parking meter. More and more communities are turning to annual plants to decorate parkways, main streets and public buildings.

George Taloumis

Above: A flagstone terrace becomes a floral carpet when plants of sweet-alyssum and thyme are added. A bonus is the fragrance from the sweet-alyssum and more pungent aroma of the thyme. Thyme will withstand some traffic, but guests must hop and skip to avoid crushing the sweet-alyssum.

Below: Morning glory is a fast-growing vine valued for its bright blue flowers. It is one of the annuals recommended for a child's garden.

nnuals appeal to new gardeners—young and old . . .

ANNUALS FOR A CHILD'S GARDEN

Frances M. Miner

ARDENING WITH ANNUALS is a good way stimulate young people's interest in lants. Many kinds are easily grown, ven by beginners, and desired results n be seen rather quickly. The whole fe cycle of annuals takes place in a ngle growing season, and plants from ed produce their flowers in a few weeks. lso, there is the simplicity of beginning ach year with a new slate.

In the Children's Garden at the Brook- n Botanic Garden, although the empha- is is on vegetable growing, a 250-foot- ng teaching border is devoted to an- uals of as many kinds as possible. After period of experience with vegetables he older children are encouraged to be- ome acquainted with various garden lowers. A few eventually participate in n advanced awards program in which ne of the requirements is the identifica- ion of forty kinds with scientific as well s common names.

This teaching border also helps further he horticultural training of new instruc- ors, who have an opportunity to start eedlings indoors and to experiment with nnuals that are attractive but may have short bloom period. Among such an- uals here are anagallis, calliopsis, China- ster, emilia, annual phlox and stock.

However, it is the better known an- uals that dominate the teaching border. They are generally the most reliable for hildren to work with, especially if seed s to be planted directly in the garden. Best suited are large-seeded, quick-germinating kinds that grow rapidly to flowering size. Marigolds and zinnias come in innumerable named varieties of large (African) and small (French) types. Their seeds germinate in a few days when the ground is warm. Sunflower is another good one, especially the smaller-flowered kinds that are not too tall for a child's garden. Calendula, balsam, cornflower and annual pinks have smaller seeds but are usually reliable.

Portulaca and celosia provide bright color but have very small seeds best planted where the plants are to bloom. Sweet-alyssum, though the seed is small, often blooms in a month and, as an edging, can be transplanted to border the garden and hold it together. Morning glory, a fast-growing vine, does best in poor soil and should have a string, fence or trellis for support. Soak its seed in warm water for a day to hasten sprouting. Key point: give children good seeds of annuals; old leftovers that won't germinate for experienced gardeners will surely dampen a young person's enthusiasm.

Petunias and snapdragons are among the annuals that capture the fancy of children, but are small-seeded and initially slow-growing. Their seeds need an early indoor start. It is wise to purchase a few young plants from a garden center.

Naturally, different plants stimulate the imagination of different children. Interest is occasionally sparked by one striking color. Also, some youngsters enjoy making a mixed bouquet. Growing a variety of annuals takes skill, and beginners need guidance to help them avoid the monotony of too much of one kind. Flowers that dry for lasting bouquets appeal to some; while experienced gardeners may want space for gourds and decorative oddities such as the unicorn plant (martynia). However, it is best to start younger children with annuals that produce results quickly.

For a very first garden, one might include a few string beans. The flowers are pretty and the familiar seed pods form quickly and grow fast. There is no plant we know of that better sparks the interest of a new gardener.

Annuals for part shade, poor soils and heat and drought

ANNUALS FOR UNUSUAL LOCATIONS

William J. Thompson

THE ANNUALS we enjoy today are derived from a wide variety of ancestral wild plants whose natural habitats range through extremes of climates and growing conditions. Therefore, no matter how unusual or difficult a particular location may seem, one can usually find a number of annuals which will flourish there easily. Because annuals must complete their life cycles in a single season, most have a vigor and persistence which enables them to survive even when growing conditions are less than ideal. With that in mind the selection can be greatly expanded if the gardener realizes which plants require special attention.

Since most annuals grow best in a sunny exposure in soil that is moderately fertile and well-drained, one can define any other location as an unusual place to grow annuals. Examples include shady gardens, excessively wet or dry soils, poor soils—also seaside gardens where plants are exposed to high winds, scorching sun and poor, sandy soil.

Shade

A shady garden is one of the most difficult sites for growing annuals. There are a few kinds, however, which do well with little sun. Wet, poorly drained soil, a problem often associated with shade, can further complicate the selection of plants. If this is the case in your garden, raise the planting bed 6 or 8 inches above the surrounding ground level to provide good drainage.

Impatience is one of the best choices for a partially shady garden. Young plants may be purchased from a garden center in spring, or they may be started indoors about two months before planting-out time. Impatience will reward the shady gardener with a profusion of

Impatience is one of a few annuals that will produce abundant flowers in partial shade. Here plants are grouped under a large crabapple tree.

George Taloumis

Coleus is another annual recommended for partial (not total) shade. This coleus planting includes the yellow-green foliage variety known as 'Chartreuse'. In fall, leaves turn golden.

flowers until frost. Some of the newer varieties have variegated foliage, and there are double as well as single flowering forms. The foliage stays lush and attractive throughout the season and will quickly signal a plant's need for water by wilting. Impatience is a very undemanding plant which thrives in the shade in average, well-drained soil.

Another undemanding annual for the shady garden is coleus. It is valued for colorful foliage rather than flowers. Seed catalogs carry a number of varieties in leaf shapes and color patterns to rival a Persian carpet. Most sorts benefit from frequent pinching to encourage branching but a few of the newer ones are self-branching and develop into compact plants with little attention. Coleus performs best in filtered sunlight, which helps bring out the leaf color. It is readily grown from seed or stem cuttings.

Last but not least of the big three in annuals for the partially shady garden is the wax or semperflorens begonia. Here again there is a wealth of varieties to choose from. Most produce glossy-leaved, compact plants 6 to 12 inches high and an abundance of dainty flowers in colors from white to pink to red. Some varieties have attractive bronzy foliage; the calla-lily types have green and white variegated leaves. All are easily propagated from stem cuttings and with a little care the dustlike seed can be germinated indoors two months in advance of outdoor planting time. Begonias grow poorly in heavy, wet soil, so make sure drainage is good.

There are many other annuals which survive in varying amounts of shade. Most, though, never reach the perfection they would in a sunnier location. Torenia and lobelia are two delightful dwarf plants which do quite well in light shade. Annual candytuft, flowering balsam and ageratum are best in some sun but perform satisfactorily in light shade. Browal-

(Continued on page 26)

Bird's-eye view of wax begonias combined with the gray-leaved dusty miller (center). Wax begonias flower quite well in partial or light shade but perform even better when planted in full sun. Contrary to popular belief, they are tolerant of some shade but do not require it.

George Taloumis

Patrick W. Grace

bove: Rocky or sandy soils,
uch as are found at the sea-
hore, can be improved with
eat moss and fertilizer to
upport growth of most an-
ual plants. Shown here is a
easide border of
frican marigolds.

ight: French marigolds
nd ageratum thrive in close
roximity to a stucco
oundation.

Gazania is an annual from South Africa with daisy flowers marked with black and green. Gazania is tolerant of heat and drought (it is popular in Southern California), but in common with California-poppy, needs an early spring start to perform well in cooler parts of the country such as the Northeast.

lia, linaria and summer- or cape-forget-me-not are able to survive the double threat of shade and wet soil.

Poor Soils

Poor soils can generally be improved to grow most of the commonly planted annuals, such as petunias, marigolds and zinnias. Heavy clay soils can be lightened by incorporating large amounts of peat moss or compost and sand. Planting beds should also be raised above grade to permit good drainage. Rocky and sandy soils, including those along the seaside, can be fortified with fertilizers and peat moss or compost to help retain moisture. Seaweed is a good source of humus.

In some cases it may not be worth the effort to rebuild a poor soil. There are a few very rugged and tolerant annuals which grow well in this instance. Certain ones in fact will flourish here and languish under seemingly more ideal conditions.

Ageratum is one such accommodating plant. It thrives in the poorest of soils and often self-seeds to reproduce itself year after year. Typically, its flowers are lavender-blue, but many hybrids exist which extend the color range to white, lavender-pink and purple. There are tall, intermediate and dwarf types, ranging in height from 3 to 12 inches.

Another good performer for soils of low fertility is the nasturtium. As with most popular annuals, there are colorful hybrids to choose from as well as large and dwarf forms. The extra bonus of the water-cress flavor of nasturtium leaves and buds in salads is also to be appreciated. However, when growing nasturtiums, be prepared for a battle with aphids.

Other annuals tolerant of poor soils include portulaca, California-poppy, annual baby's-breath, sweet-alyssum, gaillardia, celosia and cornflower (bachelor's button). With all, the gardener coping with a poor, rocky or sandy soil will succeed far more easily than the gardener with clay soil. The reason, of course, is the poor drainage common with the latter type and the bricklike consistency to which it hardens in times of drought. In

(Continued on page 28)

George Taloumis

Petunias and geraniums are combined in a narrow border between fence and walk. While petunias often perform quite well in heat and drought, the plants never rival those grown in more favorable conditions.

Perhaps impatience is the annual that is most popular today. It is at home in a variety of containers—hanging or stationary—or in the open ground in partial shade or sun.

George Taloumis

contrast, the main concern of the sandy-soil gardener is sufficient moisture for good plant growth, a task eased by mulching.

Heat and Drought

The problem of growing annuals more-or-less resistant to excessive heat and drought is common in many parts of the country. Very often it is combined with the problem of poor soil. The list of annuals suitable for such conditions is very similar to one for seaside gardeners.

A little annual frequently overlooked (except in California) for very dry, sunny locations is dimorphotheca, commonly called African daisy, a name also given to many other plants. Each plant becomes a broad mat of foliage and produces an abundance of daisy-like flowers with contrasting centers in pastel colors from white to yellow, salmon and orange. Bearing some resemblance to the former plant but on a slightly larger scale is gazania, which is available in a similar color range but with petals marked in black and green. The flowers of both species open in full sun but close in the evening and on overcast days.

In dry, sunny spots one can also rely again on such old faithfuls as sweet-alyssum, zinnia, marigold, gaillardia, California-poppy, portulaca, nasturtium and annual baby's-breath. Others to try are gloriosa daisy, salvia, snow-on-the-mountain (actually a euphorbia), sunflower, larkspur, verbena and calliopsis. Petunias are possible in these situations but never rival those grown under more favorable circumstances.

Seed catalogs are produced each year by every major mail-order seed retailer Providing illustrations, descriptions and cultural information on the seeds they stock, these catalogs become an important reference when choosing annuals for specific locations. They also usually indicate which annuals must be sown in early spring and which ones are difficult to transplant. The plants mentioned above are the most generally available and reliable for the situations described, but the curious and ambitious gardener will find many more. ☙

A DICTIONARY OF FAVORITE ANNUALS

Derek Fell

Ageratum *Ageratum houstonianum*

Tender annual, 3 to 12 inches high, blooming from early summer to autumn. Fluffy, floss-like flowers are mostly lavender-blue, although white and pink varieties also exist.

Excellent for borders, edgings, window boxes and other containers. Combines well with marigold and petunia.

Recommended varieties: Blue Angel, Blue Blazer, Blue Chip and Blue Mink—all F_1 hybrids growing about 6 inches tall. Midget Blue, an All-American winner, grows to 3 inches.

Best to start seed indoors (see page 4), or purchase young plants to set out after danger of frost has passed in spring.

Ageratum

Hollyhock *Althaea rosea*

Hardy annual, 2 to 6 feet tall, blooming from midsummer to autumn on slender stems surrounded by single or double flowers in white, yellow, pink and red. Grow it in a sunny location sheltered from wind. Usually requires staking.

Useful as a tall background plant. Hollyhock is a biennial or short-lived perennial, but plant breeders have developed a few annual types of this old favorite. Notable All-America winners include Silver Puffs, the first dwarf hollyhock (2 feet tall), and Summer Carnival (5 feet), a superb early-flowering strain in mixed colors. Both are double-flowered.

Although seeds can be sown directly in the garden, it is best to start them early indoors.

Hollyhock

Photographs from All-America Selections and National Garden Bureau

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Note: A hardy annual has seeds that may be sown outdoors before danger of all spring frost has passed. A tender annual should not be sown outdoors before the last frost is anticipated or before the ground has warmed thoroughly.

Summer-forget-me-not

Summer- or Cape-forget-me-not *Anchusa capensis*

Hardy annual, 6 to 18 inches tall, blooming from early summer to late autumn with clusters of small gentian-blue flowers.

BLUE BIRD is semi-dwarf and blends well as a companion plant with other annuals in the border. BLUE ANGEL is dwarf and so compact that it can be treated as an edging plant like lobelia or ageratum. Give both varieties full sun.

Sow seed outdoors as soon as the soil is dry, or start indoors to get healthy transplants.

Snapdragon *Antirrhinum majus*

Treated as hardy annual, 6 inches to 3 feet tall, blooming best in the cool spring and autumn months. The flowers, in spikes, come in practically every color except blue. A good border plant and excellent for flower arrangements.

Hybridization has produced spectacular kinds. ROCKET strain, in mixed or separate colors, is the tallest; plants are vigorous and produce 3-foot spikes with up to 100 flowers and buds on a stem. BUTTERFLY and BELLFLOWER strains are novel. Their flowers have flared, wide-open throats instead of the tight-lipped sort more common among snapdragons. Especially good for arrangements. FLORAL CARPET strain, in mixed or separate colors, grows to 6-7 inches and is fine for a low-growing carpet. Each plant has up to 25 tiny 3-inch spikes.

For a magnificent display start seed indoors early. Young plants can also be purchased in spring from a garden center or nursery. Snapdragons usually stop flowering in midsummer, but if old spikes are cut back, they will make new growth in late summer and provide another good show well into autumn.

Snapdragon

Wax begonia *Begonia semperflorens*

Treated as a tender annual, 6 to 10 inches tall, blooming from early summer to autumn. Flower color, often dazzling: white, pink, scarlet and red. Leaves may be green or bronze. One of the best annuals for light-to-moderate shade, also growing well in sun in all but the warmest areas. Excellent for border plantings or containers.

Compact F_1 hybrids are superior to older sorts. COCKTAIL series, in mixed or separate colors, grows to 6 inches and has bronze leaves. PINK CHARM and WHITE CHARM are taller green-leaved varieties. There are also double-flowered ones, including CHRISTMAS CANDLE, which has rose-red blooms.

Start seed indoors early, or purchase young plants in spring. They are easy to start from cuttings and also make good pot plants in winter.

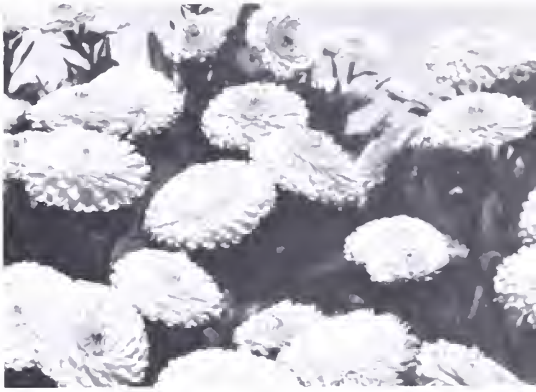
Wax Begonia

Calendula *Calendula officinalis*

Half-hardy annual, 12 to 24 inches tall, mostly in yellow and orange, and blooming from spring to autumn. Best flowering is during the cool months. Leaves have a pleasant, spicy odor. Attractive in a border, calendula also makes a good cut flower. Give it sun.

PACIFIC BEAUTY strain (18 inches) is notable. Seems to resist heat better than most. Lower-growing varieties are also available (see page 14).

Easy to grow from seed directly sown in the garden in early to midspring; or start indoors for earlier bloom. May reseed itself year after year.



Calendula

China-aster *Callistephus chinensis*

Half-hardy annual blooming from midsummer to autumn. It is among the ten most popular flowers in America, despite its relatively short bloom season. Makes a lovely display in the garden. Tall kinds make excellent cut flowers; in fact, entire plants may be uprooted for bouquets. Color range includes various lavender-blue shades—China asters have the largest lavender-blue flowers of any annual. Other colors include white, rose-pink and crimson.

The following are popular wilt-resistant strains: GIANT CREGOS, with fluffy, informal flower stalks growing 2 feet tall and individual blossoms up to 5 inches across; POWDERPUFFS, with smaller, fully double flowers and quilled centers about 3 inches across; also, DWARF QUEEN and

China-aster

Madagascar-periwinkle

Plumed Celosia

COLOR CARPET, growing just 10 inches tall, an ideal size for low beds or edgings. Aster yellows and wilt are serious problems. Select wilt-resistant varieties, and don't grow China-asters in the same place two years in succession.

For earliest bloom, start seed indoors. It can also be sown in the garden after danger of frost.

Madagascar-periwinkle

Catharanthus roseus;
formerly *Vinca rosea*

Tender annual, 4 to 15 inches tall, blooming midsummer to autumn. Best in sun, but thrives in light shade. Flowers are white, shades of rose and pink, some with a contrasting "eye." Leaves are dark glossy green, stems fleshy. Some varieties grow upright, but the most popular ones are spreaders.

Fine planted around the base of a tree, providing it doesn't have a dense canopy. Also good as a border plant, edging, ground cover, or in containers. Seems to be insect- and disease-free. POLKA DOT, an All-America winner, has white flowers with red centers. Very showy, especially in light shade.

Start seeds indoors for early bloom, or purchase young plants for the garden after danger of frost has passed.

Celosia

Celosia argentea cristata: cockscomb
C. a plumosa: plumed

Tender annual, 6 inches to 3 feet tall, blooming midsummer to autumn. Two types are popular—the cockscomb (crested) and the plumed. Gold, yellow, pink, rose and red are the basic colors. Both kinds need a warm, sunny location for vivid display. Dwarf celosias are excellent for edging, tall ones are effective in borders and make dramatic cut flowers, both fresh and dried.

Breeders have made significant improvements in this old-time garden favorite. Two notable cockscombs, All-America winners, are FIREGLOW, with cardinal-red globe-shaped blooms, and TOREADOR having gigantic red combs up to 9 inche across. Among plumed kinds to win All

Annuals in the Color Scheme

Dwarf phlox
and sweet-alyssum

Amaranthus 'Early Splendor'
dominates any garden.

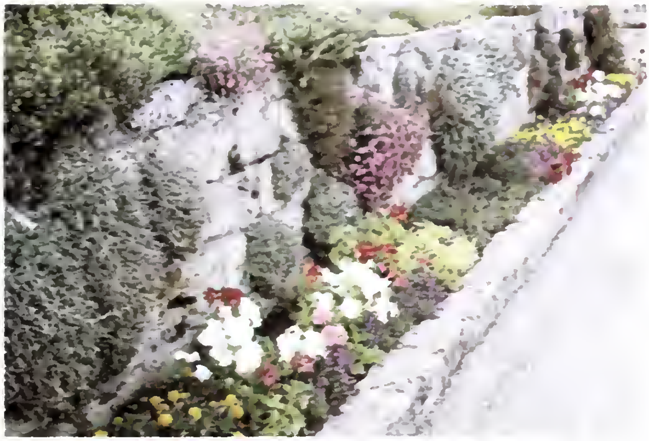
Dusty Miller as an
edging around petunias.

atum, dwarf marigold and
iums make colorful
rns.

An old-fashioned garden with plenty of flowers for cutting is favored by author Elda Haring.

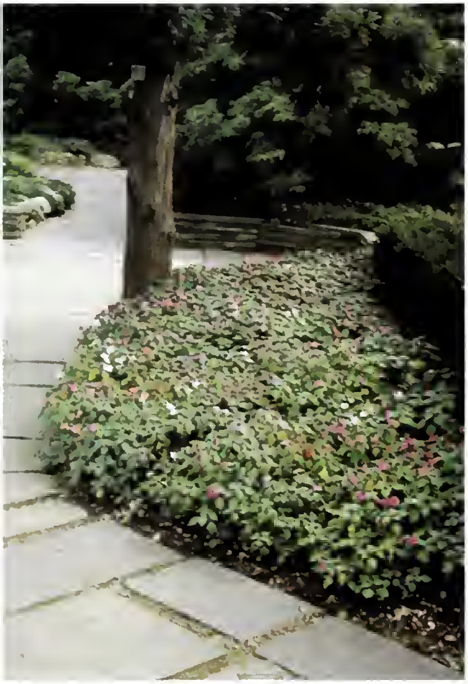
Contributor Favretti suggests planting sweet-alyssum or other lightly rooted annuals in rose borders.

Color photos by Paul Frese and Frederick McGourty, Jr.



Annuals brighten the base of a wall garden.

Three classic annuals for parts of the garden with light to medium shade: coleus (above), impatience (bottom left), wax begonias (bottom right).



America awards are Golden Triumph (2½ feet tall) with its striking golden-yellow plumes, and Red Fox (1½ feet), which has carmine red ones.

Celosia grows quickly, thrives in heat, and resists drought. Seed can be sown in he garden or started indoors for earlier lowering, but care should be taken that growth is not checked; otherwise, poor bloom may result.

Bachelor Button, Cornflower *Centaurea cyanus*

Hardy annual, 1½ to 2½ feet tall, blooming early summer to autumn, but with a shorter flowering season than most. Best in a sunny location. Thrives n poor soil and withstands heat. Blue is the traditional color, but white, pink and red are also available, separately or in mixtures.

Decorative in a flower border, cornflowers are also invaluable for cutting. Snow Ball, an All-America winner, is unusual because its pure white flowers grow on dense plants, just 1 foot tall, with such profusion they create a mound effect.

Quick and easy to raise from seed sown directly in the garden. Sow more seed later for continuous flowering.

Cleome, Spider Plant *Cleome spinosa*

Half-hardy annual, 4 feet tall, blooming from midsummer until autumn on slender stems topped with a white or pink crown of flowers. Needs a sunny location. Withstands heat.

Attractive in large groups in the border and as a background for lower-growing annuals. Useful as a temporary screen, and sometimes planted between tall shrubs. Helen Campbell, a pure white, and Rose Queen, a deep pink, are good varieties.

Can be sown outdoors in midspring, but starting indoors is recommended. Once introduced to the garden, the plants readily self-sow.

Bachelor Button

Cleome

Coleus

Calliopsis

Cosmos

Coleus *Coleus blumei*

Although a perennial in warm climates, coleus is treated as a tender annual in northern gardens. It is planted extensively for its colorful variegated foliage in combinations of yellow, lime-green, bronze, red and chocolate. Effective all season. The flowers are inconspicuous. Thrives in sun but tolerant of part shade. Height: usually about 1 foot.

Useful as a border plant, edging, or in containers. RAINBOW (mixed colors) is ideal for mass plantings because of its broadly toothed leaves and dramatic colorings. CAREFREE, a strain available in mixed or separate colors, has distinctively lobed foliage.

Start seed indoors in soil temperature of 70° to 75° F., or purchase young plants after danger of frost has passed. Desirable forms are easily rooted from cuttings and carried over winter in the house as pot plants.

Calliopsis *Coreopsis drummondii*

Hardy annual, 9 to 36 inches tall, blooming in summer. Plants grow best in a sunny location, tolerate heat, resist drought and thrive even in poor soils. The bright, daisy-like flowers are yellow, orange or red and bi-colored. Available usually in mixtures, but color selections have been made.

Dwarf varieties, which are fine for borders, form neat mounds 10 or 12 inches high; tall kinds are excellent for cutting.

Easy to grow, quick to flower when sown directly in the garden. Repeat sowings every few weeks for continuous bloom.

Cosmos *Cosmos bipinnatu*

Half-hardy annual, 3 feet tall, with feath ery foliage and masses of summer flowers in white, rose, pink, yellow and orange red. Thrives in average soil and tolerate heat. Give it full sun. Usually needs stak ing. It is an exceptional border plant and its flowers are wonderful for cutting.

Three All-America winners: RADIANCE flowers colored a deep rose with crimson zone around a golden yellow center; SUN SET, deep orange; and DIABLO, which is a ery bright and glowing reddish-orange.

Anyone can grow cosmos. Sow seed diectly in the garden after frost or start indoors for earlier flowering.

rnamental Gourds

Curcubita pepo ovifera: small gourds
Lagenaria vulgaris: large gourds

ender annuals, vining 12 feet and proucing decorative fruits in late summer r early autumn. Thrive in full sun and ich soil. Can be trained to grow up a rellis.

Small kinds are the most widely grown, ince the ripened fruits can be quickly ried and varnished to make beautiful oriaments in color combinations of yellow, range, green and white, and shapes rangng from apple, orange and pear to egg. thers resemble miniature bottles.

Sow directly in the garden after all anger of frost. Grow as you would umpkin or squash.

ahlia *Dahlia* hybrids

ender annual, 2 to 5 feet tall, bloomng midsummer until autumn in full un. Requires good soil. Both greennd bronze-leaved varieties are availble in a spectacular range and combinaion of colors (except blue).

Kinds grown widely from seed include he miniature pompom dahlias (3 feet), vhich have ball-shaped flowers, the UNVIN type (2 feet) with double and semilouble blooms having smooth or fluted etals, and the large-flowered cactus sort 5 feet). All are beautiful in borders as background planting and mixed with ther annuals in large containers.

Seed of most dahlias is best started eary indoors to get good-sized plants for arlier bloom. Dwarf kinds can be sown utdoors after the soil has warmed up. he best flowers usually appear in auumn.

arkspur *Delphinium ajacis*

ardy annual, 3 to 4 feet tall, blooming ate spring to midsummer. The bushy lants produce masses of flower spikes in vhite, blue and pink. Best in sun, but vill take a little shade. Staking is usually iecessary.

Ornamental Gourds

Dahlia

Larkspur

Dianthus

Foxglove

Larkspur, continued

Good for backgrounds and borders; also an excellent cut flower. Deep watering in dry weather helps prolong bloom period.

Grows quickly from direct sowings if planted very early in the spring. Cool weather favors good germination, rapid growth and profuse flowering.

Dianthus, Pinks *Dianthus chinensis*
Dianthus chinensis heddewigii

Hardy annual, 8 to 18 inches tall, blooming from June until autumn. Forms perfect mounds of refined foliage and colorful flowers, some smooth petaled, others serrated, in white, pink and red, plus combinations of these colors. Grow in full sun. Tolerates poor or sandy soil.

Useful as edgings, also in borders and rock gardens. In recent years breeders have developed outstanding varieties with showier flowers and longer bloom periods Notable All-America winners are BRAVO (red), QUEEN OF HEARTS (a red hybrid) CHINA DOLL (double-flowered mixture with fringed petals) and MAGIC CHARMS (first hybrid mixture).

Advisable to start indoors, but sowing outdoors can be satisfactory, too. Best flowering is in the cool weather of early summer and autumn.

Foxglove *Digitalis purpure*

Grown as a hardy annual. Height: 2½ feet. Flowers appear in midsummer. Colors include pink, rose, purple, primros and white with beautiful blotches. Th trumpet-shaped blooms are closely set o tall, tapering spikes.

Only FOXY is classified as an annua all others are biennials. FOXY blooms i five months from seed, each plant producing up to nine branch spikes su rounding a main central spike. Spikes ar not as tall as in the more common fo gloves, but make up for it in other respects. Well worth growing for garde display and cut flowers.

Where the growing season is long, see can be sown in the garden for summe display. In colder areas start indoors.

California-poppy *Eschscholzia californica*

Hardy annual, 10 to 12 inches tall, blooming from spring to early summer, but thriving best in the cooler weather of spring. Grow it in a sunny location and give it sandy soil. Plants have a spreading habit, and the poppy-like petals shine with a satin texture. Golden-yellow flowers are the most common; good mixtures contain cream, yellow-orange, pink, rose and scarlet.

A good companion for other spring bloomers; also lends itself to naturalizing.

MONARCH and MISSION BELLS are superior mixtures.

Sow in the garden where the plants are to bloom. Recommended for autumn sowing in all but the coldest areas.

California-poppy

Gaillardia *Gaillardia pulchella*

Hardy annual, 14 to 24 inches, blooming in early summer to autumn. Best in full sun. Survives heat, drought and poor soils. Single and double forms come in colors of yellow, orange, maroon, scarlet and combinations of these.

Good in the flower border for display and cutting. GAIETY (2 feet), with double flowers in mixed colors, and LOLLIPOP series (14 inches), in mixed or separate colors, are recommended.

Sow directly in the garden, or start plants early indoors.

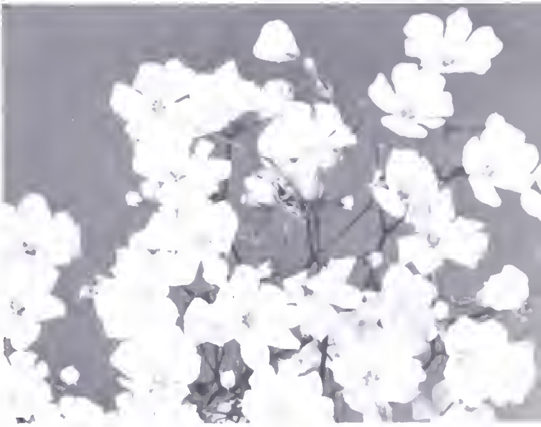
Gaillardia

Gypsophila, Annual Baby's-Breath *Gypsophila elegans*

Hardy annual, 6 inches to 3 feet, with white or pink flowers. Short bloom season, but flowers are dainty and profuse, giving a lacy effect. Best in full sun.

Useful in the cutting garden, for it provides an excellent contrast in arrangements with zinnias, marigolds and other vividly colored flowers. Choice variety: COVENT GARDEN WHITE (1½ feet), with large flowers for a gypsophila.

Easily grown in any soil, and quick to bloom. Sow directly in the garden, or start indoors for early flowering. Make several sowings two weeks apart for a continuous display.



Gypsophila

Sunflower

Strawflower

Sunflower *Helianthus annuus*

Tender annual, growing 3 to 7 feet, blooming midsummer to fall in yellow and red. Best in sun. Takes heat, drought and poor soil.

The tall, large-flowered kinds, such as MAMMOTH RUSSIA, make bold background flowers, and their meaty kernels can be saved to feed the birds in winter. This is the variety that wins in giant sunflower growing contests, some flower and seed heads reaching 24 inches or more across. SUNGOLD has double flower heads up to 6 inches wide on 6-foot tall plants. It has a dwarf version, TEDDY BEAR, just 2 feet tall with 5-inch flower heads.

The large, easy-to-handle seed should be planted directly in the soil after danger of frost. For largest flower heads, a deep, fertile soil is necessary, although sunflowers do well in a wide variety of soils.

Strawflower *Helichrysum bracteatum*

There are numerous annuals which can be included under the group name of strawflowers, but helichrysum is the most widely seen in gardens. A tender annual, it grows 1½ to 2½ feet tall.

The tall double mixture is the commonest type, producing a glistening display of colors, including crimson, salmon, rose, yellow and white. An excellent cut flower fresh from the garden; colors are retained over a long period in dried arrangements.

To dry helichrysum, cut long stems, strip away the leaves, and tie the stems in bunches of separate colors. Wrap the bunches in a newspaper cone and hang upside down in a dark, dry place.

Seed grows well when sown in the garden, or it can be started early indoors in areas where the growing season is very short.

Hibiscus Southern Belle
Hibiscus palustris selection

Can be treated as a hardy annual, blooming late summer to autumn on bushy, 5-foot tall plants. The flowers, up to 10 inches across, are white, rose and crimson with contrasting centers. Seed packets contain mixed colors.

SOUTHERN BELLE, an All-America winner, has a striking, tropical appearance. Use it in groups in the garden for bold effects or at the edge of a pond or stream.

To get flowers to first year, seed must be sown indoors very early (January or February) for transplanting when plants are a foot high. Requires 70° temperature to germinate. After frost in the autumn, plants die back. Except in very cold areas, if given protection, they will make new growth the following spring and perform as a perennial thereafter.

Impatience *Impatiens walleriana* formerly *I. sultanii*

Tender annual, 6 inches to 2 feet, blooming early summer to autumn. Queen of the shade-tolerant plants, impatience has come a long way since breeders learned to hybridize them. New ones appear every year. The color range includes white, orange, pink, rose and red. There are dwarf, semi-tall and tall types.

Excellent for edgings and borders. Also makes a good indoor pot plant. Recommended series: ELFIN (6 to 12 inches) and IMP (1 to 2 feet).

Sow seed early indoors for best results, or purchase seedlings after danger of frost has passed. Choice color forms are easily perpetuated by cuttings (see page 11).

Sweet Pea *Lathyrus odoratus*

Hardy annual vines, 8 inches to 6 feet tall, flowering in late spring and early summer. Blossoms in every color but yellow. Many sweet peas are delightfully scented. Older climbing varieties need support, new "bush-types" don't.

Sweet peas make superb cut flowers, and in the last ten years breeders have made some major improvements. Recommended series: JET SET. It is a distinctly superior bush-type sweet-pea and is available in fifteen hues. The large flowers are supported by long stems on short vines, producing a remarkable density of color. Like all sweet peas, JET SET provides superb cut flowers. Among dwarf bush types, perhaps the most impressive is the BIJOU series, growing just 12

Hibiscus

Impatience

Sweet Pea

inches high, but producing 5- to 7-inch stems with 4 to 5 flowers to each stem.

Where winters are mild, sweet peas can be sown outdoors in autumn, mulched, and relied upon to flower in early spring. However, in cold areas it is best to plant seed outdoors in early spring as soon as the ground can be cultivated. Starting seed indoors in peat pots to get 6-inch healthy transplants is also a good method, especially where summers soon become hot. Sweet peas cannot tolerate heat and must be grown to flower as early in spring as possible. To hasten germination, soak the bullet-hard seeds for 24 hours in water. Soil for sweet peas should be fertile, well drained and in a sunny location.

Sweet-alyssum

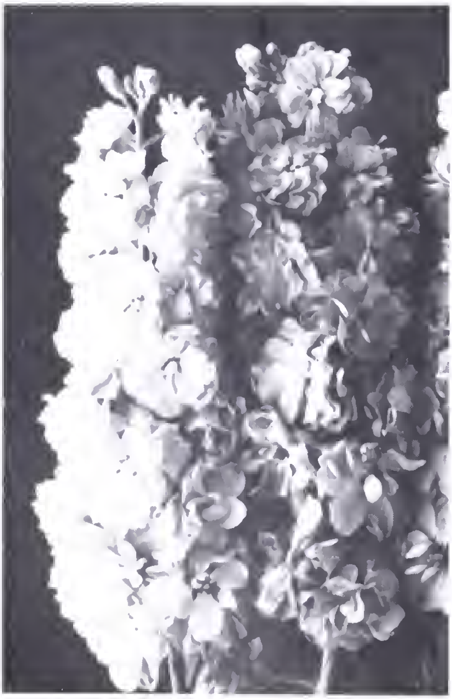
Sweet-Alyssum *Lobularia maritima*

Hardy annual, 3 to 8 inches tall, blooming from early summer to autumn. Dainty, fragrant flowers are freely produced on mound-shaped plants. Best in sun. Tolerates heat, and blooms quickly from seed. Colors include snow-white, rose, pink and purple.

Possibly the most popular plant for edging a flower border. Excellent as a companion for taller plants in containers; also for rockeries and between stepping stones. Especially beautiful when the white kinds are alternated with blue lobelia (*Lobelia erinus*), another fine edging plant.

Carpet of Snow (4 inches) forms a dense low-spreading white mat. Rosy O'Day (3 inches) is a lovely deep rose, and an All-America winner. Royal Carpet (3 inches) is a violet-purple, also an All-America winner. Snowdrift (3 inches) and Oriental Night (dwarf deep purple) are also very good.

Quick and reliable from direct sowing in the garden in midspring.


Stock

Stock *Mathiola incana*

Hardy annual, 1 to 2 feet tall, blooming from spring to early summer. The fragrant flowers are borne on heavy spikes. Colors: wine red, royal, purple, white and pink, usually available in a mixture. Best in full sun, but satisfactory in part shade

Excellent as a cut flower and often grown in gardens for that reason as well as its scent.

Popular for garden use are the DWARF TEN WEEK and GIANT IMPERIAL strains. For cutting, the COLUMN type is recommended.

Stock cannot tolerate heat in the early growing stages, and must have a temperature of 65° F or less in order to produce a good set of buds. For best results start seed indoors. Otherwise sow very early outdoors.

Four O'clock *Mirabilis jalapa*

Treated as a tender annual, 2 feet tall, blooming midsummer to autumn in all colors except blue. Some flowers are even striped. Grow in a sunny location. This old-time favorite takes heat, drought and poor soil. Bushy plants are covered with flowers which open in the afternoon on sunny days, and stay open all day on cloudy days. Useful as a border plant, or as a temporary hedge.

Easy to grow, but best from seed started indoors. Seedlings frequently appear in the garden in succeeding years if winters are mild, and occasionally the tuberous roots will live over if frost has not deeply penetrated the soil.

Bells of Ireland *Molucella laevis*

Half-hardy annual, 10 to 36 inches tall, blooming from mid- to late summer. Stems are closely set with decorative green, bell-shaped bracts and a dainty white flower at the center. Does best in full sun and tolerates heat. Decorative in a border, but Bells of Ireland are principally grown for cutting to make attractive arrangements.

Seed is hard-skinned and sensitive to cold. Normally does well when sown in the garden and supplied with ample moisture as the soil becomes warm.

Nicotiana *Nicotiana alata*

Half-hardy annual, 1 to 3 feet tall, blooming midsummer to fall. Thrives in sun, but will tolerate part shade. Resists heat and drought, performs satisfactorily in

Drury

Four O'clock

Bells of Ireland

Nicotiana

Shirley Poppy

Petunia

poor soil. The fragrant, star-shaped flowers grow at the ends of long stems on bushy plants that bloom early and freely all season. Colors include crimson, pink and white. Leaves are large, almost bold. Nicotiana, known as flowering tobacco, is useful in the middle or back of the border, and as a cut flower.

Primarily an evening bloomer. Exception: DAYLIGHT strain. Lower-growing varieties of nicotiana including CRIMSON BEDDER and WHITE BEDDER, both 12-18 inches high, are popular. One variety, LIME SHERBET, has yellow-green flowers.

Seed can be sown directly in the ground after danger of frost, or started indoors. Volunteers frequently appear in succeeding years.

Shirley Poppy *Papaver rhoeas*

Hardy annual, 1½ feet tall, blooming from early summer to autumn. The delicate, brightly colored flowers are produced in many shades of pink, salmon, apricot and red, some edged in another color to create a two-tone effect. The large golden-yellow anthers create a lovely contrast. Useful in borders and for naturalizing on a sunny bank.

Poppies perform best when sown in early spring in the garden, with no transplanting, as they produce their best floral display during cool weather.

Petunia *Petunia hybrida*

Half-hardy annuals, growing 1 to 2 feet, and flowering from midsummer to fall in an extensive color range, including some beautiful bicolors. Useful for borders, edgings, window boxes, pots and other container plantings. The four most popular classes of petunia are the grandiflora single-flowered (giant, flat flowers), the multiflora singles (smaller-flowered, but more of them and providing a greater density of color), the grandiflora doubles and the multiflora doubles.

Every seed catalog contains an extensive listing of varieties. Hybridizers still believe many improvements can be made. Some outstanding selections are BURGUNDY velvety deep purple, heavily veined grandiflora), WHITE CASCADE (gigantic ruffled grandiflora), and APPLEBLOSSOM (lovely frilled pink grandiflora, and an All-America winner). Among multiflora types, COMANCHE (red) and CORAL SATIN are two All-America winners. Among doubles, CIRCUS is a beautiful bicolored red-and-white grandiflora (also an All-America winner).

For best results petunias should have full or nearly full sun. They thrive with frequent watering, but don't drench the delicate flowers.

Seed is tiny and should be started indoors; or young plants can be purchased after danger of frost has passed. The double-flowering sorts are challenging to germinate. Sprinkle their seeds sparingly on a wad of tissue paper and make it into a roll, keeping it moist and warm. After the tiny seedlings have sprouted, transfer them with care to individual peat pots for later transplanting.

Annual Phlox *Phlox drummondii*

Half-hardy annual, growing 7 to 15 inches high, from early summer to autumn in an extensive color range, excluding true yellow and orange. Thrives in full sun and is heat-tolerant.

Use tall kinds in borders, low-growing ones as edgings in borders and in container plantings. All-America winners: GLAMOUR (15 inches), bearing large salmon flowers ideal for cutting; TWINKLE (7 inches), a dwarf mixture having an almost endless variety of colors. Some of the flowers are delightfully fringed, others star-shaped, and many in two-color combinations.

Can be sown directly in the garden or started indoors. Successive sowings insure all-summer bloom.

Portulaca *Portulaca grandiflora*

If you have a hot, dry part of the garden that needs brightening consider portulaca. Sometimes called moss-rose because the flowers resemble miniature rose blossoms, it is a low-growing, fleshy-stemmed, tender annual. Blooms from early summer to autumn, but is at its best in the hottest months.

Flowers single or double, from white

Annual Phlox

Portulaca

Salpiglossis

Salvia

and yellow to pink and red, and available in mixtures or separately. Typically the blossoms close at night and on cloudy days (but see page 63). Portulaca requires full sun and tolerates poor soil. Height: No more than 6 inches.

Quick and easy from seeds sown in the garden well after danger of frost has passed. Scatter the tiny seed very thinly.

Salpiglossis *Salpiglossis sinuata*

Half-hardy annual, 2½ feet tall, blooming from midsummer to autumn. The brilliantly colored petunia-like flowers have a velvety texture and are heavily veined in contrasting colors. Flower colors are yellow, orange, red, pink and purple, commonly sold in mixtures. Best in a sunny location. Excellent display flower in the garden and useful for cutting.

Start seed indoors and set young plants out after danger of frost has passed.

Salvia *Salvia splendens*

Tender annual, 7 to 24 inches tall, blooming from early summer to autumn. Mostly grown for its blazing red flower spikes, but pink and blue varieties are available. Grow in a sunny location. Takes heat, drought and poor soil. Invaluable for edgings, borders, beds and container plantings. Many varieties, in different sizes and hues, are available.

Start seed indoors or purchase young plants in spring.

Marigold *Tagetes erecta:* African
Tagetes patula: French

Half-hardy annual; 6 inches to 3½ feet, blooming from late spring to autumn. Flowers single or double, in various sizes and shapes. Yellow, orange and rusty-red are the basic hues, which are vivid, and there are bicolors. Grow in sun. The plants are tolerant of drought and poor soil. Insect and garden pests seem to avoid marigolds, perhaps because of their spicy odor. Some vegetable gardeners interplant them among cabbage and beans for protection from rabbits. The roots also repel some types of nematodes.

Probably no garden flower is less trouble to grow, has a longer period of bloom or has more decorative value, both inside and outside the home, than the marigold. There are two kinds—the dwarf French and tall African (American).

French marigolds are useful in borders and in any situation where a low-growing plant is needed. Good for containers, too. Among numerous varieties and forms are two excellent ones, GYPSY and PETITE. NAUGHTY MARIETTA, single-flowered, is a lovely red and yellow bicolor with a daisy-like appearance. Choice larger-flowered ones include BOLERO (All-America winner), CARMEN, FIESTA and SPARKY.

The largest-flowered African marigolds, which bloom later in the summer, are the JUBILEE, CRACKERJACK and CLIMAX series. The first grows 2 feet tall, the others to 3 feet. An outstanding All-America winner is SHOWBOAT, a dwarf triploid. Dwarf triploids are crosses between French and African, producing large, long-lasting blooms on low plants.

Seed of all marigolds, except triploid hybrids, does well when sown in the garden, although starting indoors is recommended for earlier blooms.

Marigold

Nasturtium *Tropaeolum majus*

Half-hardy annual, 12 inches to 3 feet, blooming from early summer to fall. Needs full sun, and does well in heat, drought and poor soil. Colors predominate in yellow, orange and red.

Dwarf varieties are good for borders and containers. Trailing kinds will climb up a trellis, cascade over window boxes and cover banks. The flowers make lovely arrangements. The whole plant is edible, the stems, flowers and leaves having a spicy flavor similar to garden cress. They are delicious in salads. Seeds may be pickled in vinegar.

Double dwarf JEWEL and semi-tall GLEAM, both in separate or mixed colors, and ALASKA, with a compact habit and variegated foliage, are recommended.

Sow seed directly in the garden, or start early indoors in peat pots. Do not plant in an overly rich soil, as it encourages foliage at the expense of bloom. Germination is hastened by soaking the hard seeds overnight in a glass of water.

George Taloumis

Nasturtium

Verbena

Zinnia

Verbena *Verbena hybrida*

Half-hardy annual, growing 6 to 12 inches high, blooming from midsummer to autumn in a wide range of colors, including white, lavender-blue, red, pink and salmon, some with contrasting "eyes." Flowers grow in tight clusters, on tough, spreading plants which form a dense colorful carpet, withstanding heat and poor soil. Best in sun.

Verbena is useful for edging, as a ground cover and in the rock garden. Although mixtures such as IDEAL FLORIST, RAINBOW and SPARKLE are popular, some individual colors have won All-America awards: AMETHYST for its lovely lavender-blue flowers and BLAZE for its dazzling bright scarlet ones.

Sow seed directly in the garden after danger of frost, or start indoors to get healthy transplants for earlier bloom.

Zinnia *Zinnia elegans*

Tender annual, 6 to 42 inches tall, blooming from midsummer to autumn. Brightly colored flowers in various shapes, sizes and hues, including white, yellow, pink, red and orange. Best in full sun. Garden uses are similar to marigold.

Giant cactus-flowered types, with blooms up to 6 inches or more, are the most popular. They have quilled, ruffled petals. Next in popularity among the giants are dahlia-flowered types, with wide flat petals forming a rounded flower head up to 5 inches across. Giant tetraploid varieties, of which STATE FAIR MIXTURE is a good example, have even larger blooms than the dahlia-flowered type. They also are more disease-resistant.

Almost as popular are the dwarfs. Among these is THUMBELINA, a gold medal All-America winner growing no taller than 8 inches. It blooms when only 3 inches tall.

PETER PAN types, F_1 hybrids, are a breeding achievement. They grow to a foot and have dahlia-type flowers up to 3 inches across. Plants are bushy and compact. Best in mass plantings.

Zinnias are easy and dependable from seed sown directly in the garden. Or start seeds indoors or buy young plants. ☘

An ancient garden practice that has special appeal for modern gardeners

ANNUALS IN CONTAINERS

George Taloumis

THERE is nothing new about growing plants in containers outdoors. It was a common practice in ancient Egypt, Greece and Rome. Every culture, western and eastern, has realized the merits of this form of gardening and the distinctive beauty that plants, even the most common kinds, assume when grown in a pot, urn, planter or hanging basket.

Gardening in containers has many advantages, of which present-day growers are increasingly aware. While the practice is old, it has become adapted for today's way of life. There is a mobility, a portability about container gardening that has particular appeal to homeowners now. The picture can be changed any time that is desired, as furniture in the house can be rearranged for new effects, by using what is already available or perhaps by adding a new item or two.

Appropriate Plants

Plants in containers, whether annuals, various mild-climate perennials treated as annuals, or even shrubs such as yews in urns that grace a doorway, are often more picturesque than when set in the ground. In fact, any plant is eligible, provided the principle of scale is observed. With careful selection, container plantings can present an architectural quality, the sum of which is greater than its parts. This may be true even in the case of the most simple country dwelling, as has been noticed by American travelers who have admired the container-growing accomplishments of villagers in the poorer sections of Europe's Mediterranean countries—Portugal, Spain, Italy and Greece.

Plants with a rather short flowering season or ones with a distinct spring peak, such as pansy, English daisy, annual forget-me-not and nemesia, are often more effective in containers than in borders because they can simply be whisked out of sight when blossoms have gone, leaving no conspicuous gap in the landscape. Summer-bloomers can take their place.

Also, as occasionally happens in even the best of gardens, if a container planting of petunias on a sun-parched terrace

George Taloumis

There's hardly an annual that isn't suited to pot culture. Here seeds of moonflower have been planted in a small tub and the vines supported on bamboo stakes.

Petunias thrive in containers. Here an ancient, rough-hewn log holds white petunias.

dries up because it was not watered, removal is an easy task—and no one but the gardener will be the wiser. Besides, if it's the latter part of summer, it might be time to replace them anyway with a pot of budded chrysanthemums, available at a modest price from most garden centers then. The various autumn-flowering chrysanthemums are perennials but can be treated as annuals for container purposes, extending the bloom season until nearly winter, when they may be replaced with such materials as evergreen boughs, cones, berries, dried strawflowers, red ruscus, and silver or frosted twigs and branches.

However, it is mostly plants with attractive flowers that come to mind when we think of containers. Among the classic ones are geranium and sweet-alyssum in window boxes; cascade petunia, lantana and fuchsia in hanging baskets; and, in parts of the country with cool summers, tuberous begonias in earthenware pots shaded by large trees. Other popular plants for continuous color include marigold (low-growing yellow and orange kinds), impatience, wax begonia, calendula (in large containers), dwarf dahlia, browallia, and dimorphotheca and portulaca, both of which open with the sun and close in shade.

Annuals grown for their ornamental foliage have a place in container gardening and can be as attractive in their own way as ones with showy blossoms. Some even give a flowering effect when seen from a distance. In their multitudinous forms, alternanthera, coleus and dusty miller are useful contrast or accent plants. Bronze-leaved sorts of wax begonias and impatience with mottled foliage extend the range. Variegated vinca, a trailing plant grown from cuttings, graces many container gardens in summer.

Sun and Shade

Container plants treated as annuals are generally so easy to grow and have such a long flowering season of their own that there is no need to go into detail here about their culture. Most of them, including petunia and marguerite daisy, a favorite pot plant in mild-climate gardens around the world, need full sun for best

Above: A variety of plants, mostly annuals that can be grown from seed, are featured in this backyard pot garden. Included are such culinary herbs as Greek basil, parsley and oregano, geraniums and some scented-leaved types and petunia.

Right: Suitably decorative for a terrace is a strawberry jar planted with petunias.

flowering. However, a point to remember is that sun-dwellers can be shifted temporarily to a shady spot on special occasions, as when visitors are entertained. Tubs on casters can be an invaluable aid for the mobile garden.

Other plants, such as impatience, coleus, caladium, browallia, fuchsia (a shrub in warm areas) and various begonias perform admirably in shade or part sun. Lobelia tolerates light shade very well. Several house plants, among them episcia, achimenes, *Begonia richmondensis* and assorted ivies, are satisfactory outdoor container plants for shady areas. For summer effect in the garden, it is possible to start a number of house plants from cuttings in the house in late winter. (See Brooklyn Botanic Garden *Handbook on Propagation.*)

Containers

Many kinds of containers are available. Clay types have a traditional, earthy look and fit in anywhere. Wooden containers, especially the durable redwood ones, are always attractive. Very common today are plastic pots, of which there are hanging basket variations, too. They have the advantage of being lighter and holding moisture longer than clay pots. Outdoors this is beneficial because containers can become dry very quickly in the hot summer sun, but indoors it is easy to overwater plants in plastic pots. With experience the new gardener soon learns how much to water and when.

Widely available, and much sought after by balcony and rooftop gardeners, are jardinières. Some of these ceramic containers are decorated, others come in solid colors. Both types are handsome and rich in appearance. Some have drainage openings, others don't. The latter must be placed on porches, under awnings, or in other locations where they are not subject to constant rains, as roots of potted plans standing in water do not take long to rot.

Window boxes, through the centuries, have proved to be the most popular outdoor containers. To travelers they revive memories of picturesque small towns in Switzerland, Austria and Germany. Window boxes are ideal for our own city apartments, too. The first step, as with

White petunias and geraniums cascade from a window box outside of a city dwelling.

other containers, is to make certain drainage is perfect. This means placing broken pieces of old clay flower-pots, large pebbles or rough stones at the bottom, so water will pass through freely.

A basic soil mixture for container plants consists of equal parts of good garden loam; peat moss, leafmold or compost; and perlite, vermiculite or sand. To this, add a heavy sprinkling of a mixed, balanced fertilizer. In addition, thoroughly mix in a few handfuls of bonemeal or superphosphate, both of which promote flowering.

Care

With annuals and other container plants, it is wise to adopt a heavy feeding program. Have you ever noticed how closely petunias, sweet-alyssum or dwarf marigolds are planted in window boxes and other containers? Usually just 3 to 4 inches apart. This is necessary for immediate ornamental effect but, set so closely, plants require extra nourishment because they soon exhaust most of the nutrients available in the soil. Every ten days or two weeks, use a balanced fertilizer such as 5-10-5, in liquid or dry form, as recommended for containers. Make certain the soil is always moist when fertilizer is applied, and with dry applications add even more water to avoid burning the plants.

Continue fertilizing into autumn. Unlike shrubs and trees, in which late feeding stimulates soft growth that is apt to winterkill, annuals can only benefit from additional nutrients in the latter part of the growing season. After all, as annuals, they will die at the end of the season, so get the most flowering from them you can. In any event, the dyed-in-the-wool container gardener is not discouraged by an early frost. Patios and balconies, warmed by buildings, often don't receive the first touch. Also, tender annuals may be moved indoors overnight, and some kinds, including geranium and sweet-alyssum, can bloom for several weeks thereafter. Snapdragons frequently survive hard frosts and can be effective until late autumn in some years.

A neat appearance is of extreme importance with container-grown plants.

(Continued on next page)

Plants with short flowering seasons, such as forget-me-nots, are more effective in containers because they can be discarded as they fade. Summer bloomers are easily moved in to take their place.

Faded geranium and petunia blossoms may pass unnoticed in flower borders, but not so in window boxes or tubs on steps by the front entrance. Keep clipping old blossoms constantly and also remove yellowed and disfigured leaves. Severely pinch back the top growth of plants that become leggy or unusually sprawling. Petunia, verbena, Madagascar-periwinkle, impatience and even wax begonia may require this in the latter part of the season to remain compact. Trailing plants used for contrast, such as variegated vinca, some pelargoniums (ivy-geranium) and ivies, and sweet-alyssum, may also need cutting back.

Stake tall-growing plants like cosmo cleome and African marigolds in larg containers if you decide to grow them a bold accents. This must also be don should you include morning glory, cobae thunbergia or other annual vines fo architectural variation in the containe garden. Briefly, give plants in containe that extra care, as they act as focal poin in your garden, large or small, in the cit suburb or town. Annuals and annua alone will provide you with all you e pect in the way of color and lasting pe formance in the flowering year.

Why Doesn't My Geranium Flower?

THIS is one of the questions most commonly asked by gardeners, new and old. The chances are the plant is growing in too much shade. Geraniums need good light all day long to bloom well, so take this into consideration when selecting plants for window boxes and planters. The more shade, the fewer blossoms there will be. Also, contrary to myth, starvation of geraniums is not necessary for good flowering. In fact, given a soluble fertilizer every couple of weeks if summer rains are normal, and less often in drought, geraniums will justify their extra care with better growth and more abundant blooms. (Make sure soil is moistened before fertilizing.) This is true of annuals, too. The common enemy of most plants, apart from inadequate light, is poor drainage. This applies especially to geraniums, which are subject to stem rot, black leg disease and other maladies if the soil is continually soggy.

Geraniums, which are tender perennials in the North (and woody shrubs in frost-free areas), are being increasingly used as bedding plants. One reason for this is the new Carefree strain, which can be grown from seeds sown in the house in January to produce plants that will flower outdoors by late spring. Several colors and shades are available.

People have favorite ways of carrying geraniums through winter in the North. About eight weeks before killing frost, some gardeners like to take cuttings, which are easily rooted in a mixture of half-sand and perlite. After watering, place pot in polyethylene bag with a large air bubble so foliage doesn't touch the bag. Others prefer to put last summer's geraniums, pots and all, in a dark, cool room in the basement, watering them lightly but once or twice in winter and only if the more woody portion of the stems begin to shrivel. Grandma's favorite way, of course, was to shake the soil from the roots and hang the geraniums upside down in a dark attic. Each method works, and there can be variations on a theme, so experiment to see what is best for your situation.—*Edmond O. Moulin*

The multitude of varieties, colors and forms are able to satisfy any gardener's esthetic requirements

ANNUALS FOR INDOOR DECORATION

Elda Haring

ANNUALS have a special place in my garden. They are indispensable interplanted in my bulb and perennial border for a spectacular color display through the entire growing season. Annuals also frame walks and drape foundations in living color to transform the drab into a pleasant and colorful environment. My greatest pleasure, however, is derived from a cutting garden which provides plenty of flowers for indoor decoration all summer and enables me to give arm-loads of flowers to friends. Garden club associates have always been welcome to come and help themselves to flowers for their arrangements to exhibit in flower shows, and if they win the coveted blue ribbon their happiness is no greater than mine.

When choosing annuals to grow in the garden for indoor arrangement, it is desirable to include kinds with flowers in spikes, which are used to outline the arrangement. My favorites for this are snapdragon, plumed celosia, bells of Ireland, salvia, larkspur and stock. I also like to grow annuals with rounded, fuller bloom forms for central interest, such as zinnia, marigold, aster, rudbeckia, calendula, crested celosia, cosmos and tithonia. For airy and lighter flowers to be used as filler and contrast I grow statice, cornflower, Mexican tulip-poppy (*Hunnemania*), salpiglossis, ageratum, baby's breath and the various gray-leaved plants called dusty miller, of which my favorites are 'Diamond' and 'Silver Lace'. All of these are easily raised from seed.

Cutting

If space permits, a separate cutting garden is very desirable. It can be placed in an out-of-way area or in the vegetable garden where flowers can be picked to the heart's content. However, annuals used mainly for seasonal color in the garden can provide adequate material for arrangements if care is taken to cut a spike, spray or single bloom at random so that the overall display is pleasingly retained.

Cutting beds should be kept well watered if the weather is dry, as flowers that are limp when cut will not last. Avoid picking flowers at mid-day. Early morning or after a sundown is the best time for cutting although late afternoon is acceptable because it allows adequate time for conditioning. Take a bucket of warm water with you to the garden and as you cut a flower immediately place the stem end in it. Choose blooms at their peak, including some buds and half-opened flowers as well.

After bringing cut flowers into the house I like to gently wash them off with warm water while supporting the blooms so that they will not be damaged. This treatment eliminates dust and insects that may be present. The bottom of the stems are then recut and the lower leaves removed. Let at least two leaves nearest the blossom remain. Replace them uncrowded in a bucket in deep, quite warm tap water. Keep containers in a cool place two to three hours but preferably overnight to condition the flowers before arranging.

Bedding dahlias grown as annuals, poppies, heliotrope and other varieties that bleed at the cut are sealed by placing stem ends in very hot water from the tap for at least ten minutes. Many arrangers prefer to sear the stem ends of these flowers by burning the bottom inch or immersing them in boiling water for a few seconds. Several excellent commercial preservatives are available to prolong the life of cut flowers. Aspirin,

Annuals such as celosia, larkspur and statice are combined with the perennials globe thistle, dock and artemisia in this arrangement.

which is often recommended, I have found of no value in this regard. The addition of one tablespoon of sugar to each quart of water is also considered an aid to extending the life of cut flowers.

You needn't have experience to arrange annuals for the home, but a few basic procedures should be followed to better display them for your own enjoyment. Whatever container you choose, a pin holder is needed to anchor the flowers. Firmly fasten the holder with florist's clay in the bottom of the container. Use the tall spire-form flowers for the outline, the round, larger blooms for main interest and medium types for fillers.

The basic designs for flower arrangements are crescent, horizontal, circular, oval and triangular. When you have decided on a design, place the tallest flower firmly in the pin holder about one-and-a-half to two times the height of the vase. If a shallow container is employed, the width of the arrangement should be one to two times the length of the container. Add other spikes of different lengths to complete the basic design, then the heavier, rounded forms for center of interest, and fill in with lighter flowers. Blooms should never be crowded but should be arranged loosely and in a graceful fashion. Better to err on the side of too few rather than too many.

For Winter Decoration

Annuals can also be dried for winter arrangements. The modern methods and materials used to preserve them produce flowers so perfect as to almost appear fresh picked from the garden. In selecting blooms or foliage for drying, the harvesting criteria are even more critical than for fresh arrangements. Select flowers at or preferably just prior to their peak. Gather buds and partially open blooms to add interest and contrast in the bouquet. Unlike flowers for fresh arrangements, annuals for drying must be cut at noon or early afternoon when there is no vestige of dew on the petals. It is best to take a container of warm water to the garden and place stems of cut flowers in at least an inch of water. Flowers for drying should be crisp and fresh. If they cannot be immediately prepared for drying they should be conditioned and kept in water until ready for processing.

Some annuals can be stripped of leaves and hung in small bunches in a dry, airy place. Secure the stems with a rubber band to hold the bunch intact because the stems shrink during the drying process. Large and many-petaled blooms require a longer drying period than more delicate types. Air drying for two to three weeks, depending on temperature and humidity, is necessary. When completely dry, store them in a dry place and cover with tissue paper to keep dust away.

Annuals that lend themselves to the air-drying method include statice, strawflower, baby's breath, celosia, bells of Ireland, globe-amaranth, jewels-of-Opar (seed spray), love-in-a-mist or nigella (seed pods) and blue and red salvias, as well as the ornamental grasses.

Many annuals dry to perfection in a desiccant or drying agent containing silica gel. There are a number of these on the market, including Petalast, a product

A summer's bounty—zinnia, celosia and larkspur are enhanced by roses and perennial baby's-breath.

Roberta Moffitt

formulated by Roberta Moffitt, whose arrangements accompany this article. It is a special blend of silica gel, a white sand-like chemical containing blue crystals that removes the moisture from flowers in three to seven days. Again, choose the same bloom forms as those used for fresh bouquets—spikes, rounded and airy.

To preserve the flowers in a desiccant, use a plastic box with cover. A sweater box is ideal. With single or double flowers like zinnias or marigolds cut off the blossoms heads, leaving one inch of stem. Insert a 2- or 3-inch piece of medium-weight florist's wire into each stem, pushing it up into the calyx, then bend wire horizontally, set flower face up on one inch of silica gel, and surround the petals with the desiccant. If flowers are double, as in many marigolds, sift the material in between the petals to preserve the form of the flower. Cover entirely with the drying agent. Spike-like flower stalks, such as those of snapdragon and larkspur, should be laid flat and alternated to conserve space. Gently push some of the silica gel into each floret, then cover stem and flowers completely. Seal the box and mark with the date.

Allow three to seven days drying time and keep flowers in the container until they feel crisp to the touch. Do not leave them in the desiccant too long because the lovely colors will fade. To remove the flowers from the box, tip the container to let some of the material slide out, and carefully lift each flower while supporting it with the fingers. Use a soft brush to remove any desiccant left on the petals and stems. Store in air tight boxes containing one-third cup of Petalast on the bottom until ready to use.

When arranging dried flowers, use one of the plastic foams available at the florist or garden center to support the stems in the container. Use florist's wire and tape to lengthen the stems as needed to create the design you have selected. Bouquets and arrangements of dried flowers are long lasting, carefree and a delightful visual reminder of last season's joys.

In addition to the plants mentioned above, the following are satisfactory for drying by the silica gel method: ageratum, summer- or cape-forget-me-not (*Anchusa capensis*), arctotis, bells-of-Ireland, blue-lace flower (*Trachymene*), calendula, Chinese forget-me-not (*Cynoglossum*), clarkia, cornflower (bachelor's button), cosmos, dahlia, dusty miller (especially 'Diamond'), feverfew, gazania, gerbera, gloriosa daisy, heliotrope, love-in-a-mist (*Nigella*), scabiosa and stock (*Mathiola*). ✤

Fragrance, colorful foliage, decorative seed pods . . .

ANNUALS WITH SPECIAL QUALITIES

Klaus Neubner

FRAGRANCE can be an important quality in the garden, but most annuals today are bred for color and form. Generally we must turn to the "old-fashioned" annuals for fragrance. An exception is the petunia, for many of the spectacular F_1 hybrids have kept their delicious scent. It is most noticeable after sunset.

The following annuals are best planted in parts of the country where summers are not exceedingly warm. Hot humid weather prevents them from developing properly or causes sparse flowering. They are carnation, nasturtium, scabiosa, stock, sweet-alyssum, sweet pea and the annual varieties of sweet William. The flowers of mignonette (*Reseda odorata*) are not showy, but they are among the most richly perfumed in the world of annuals. Modern F_1 hybrids of pansy, such as the Majestic Giant strain, have retained their fragrance.

These annuals, which tolerate moderate as well as hot summers, may be planted anywhere: bartonia (*Mentzelia lindleyi*), basil 'Dark Opal', southern star (*Exacum affine*), scented geraniums, heliotrope, nicotiana and annual phlox.

Colorful Foliage

Coleus and amaranthus, in their numerous varieties, immediately come to mind, but there are many others, too. Polka dot plant (*Hypoestes sanguinolenta*) is one of the most distinctive because of its bronze, heart-shaped leaves with pink dots. It eventually forms a bushy, 2-3-foot plant and needs no pinching to remain compact. Growth is very good in full sun or light shade. For best effect, plant a group next to annuals with light-colored flowers or against a white building. It is also decorative as a miniature sheared hedge in the flower border.

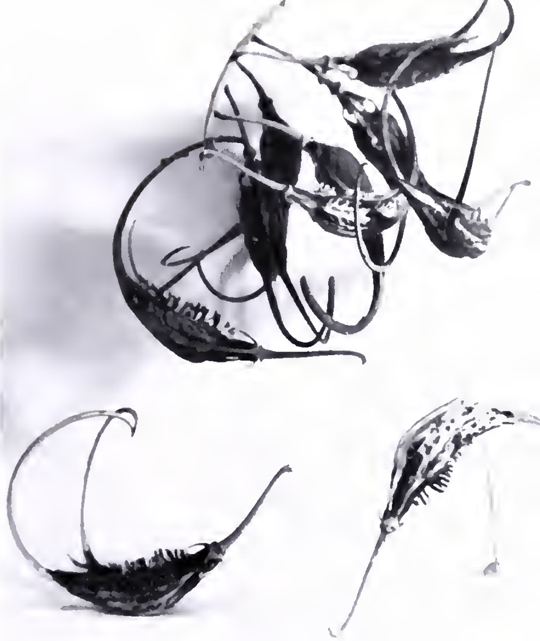
Dusty miller, of which there are several kinds belonging to different genera, is most frequently represented by *Senecio cineraria* (*Cineraria maritima*) in its garden forms. A perennial in the mild winters of the southern United States, it can be grown as an annual everywhere. The finely cut, silvery, velvety foliage is especially attractive when plants are set next to annuals with red, blue or deep golden flowers. It is also used to separate clashing colors in the garden. The average height of dusty miller is 6 to 10 inches tall, though some forms grow taller. 'Diamond' and 'Silver Queen' are best known. 'Frosty' has the most finely cut, lacy foliage.

Perilla frutescens 'Fancy Fringe' grows to 2½ feet. The bushy plants have deeply cut leaves with a metallic maroon luster that resembles the foliage of some coleus. Grow perilla in full sun or light shade. A group next to plants with white, light pink or light yellow flowers is striking. Basil 'Dark Opal' gives almost the same effect but grows only a foot tall and has attractive spikes of pink flowers. Although a culinary herb, it is unusually ornamental and entirely at home in the flower garden.

Consider the ornamental peppers (forms of *Capsicum annuum*), too. I know of no kind of plant with darker foliage than 'Black Prince'. It is a compact grower, to 10 inches tall. In late summer small, pointed, lavender peppers are formed. They turn red just before frost. Another attractive plant is the variegated ornamental pepper. The growing tips have leaves that are old-rose and white. Older foliage turns green with spots of white and rose, giving a tie-dyed effect. In late summer this pepper bears green, black and purple fruit.

Snow-on-the-mountain (*Euphorbia marginata*), an old-time favorite not too often seen in gardens today, is also excellent for a variegated effect. It has foliage

The ornamental pepper *(Capsicum)* 'Fips' has clusters of inch-long yellow, rocket-shaped fruits on 8-inch plants in late summer.



Unicorn plant or martynia bears 5-inch seed pods that split open when dried. They are then made into whimsical creatures.

George W. Park Seed Co.

Summer-cypress or kochia grows 2 or 3 feet tall and resembles a small coniferous evergreen. In the fall, the foliage turns red.

Ornamental kale has decorative foliage of rose, cream or white tints, the colors becoming most intense after a frost occurs.

and flower bracts with white margins and is a cooling sight on a hot summer day. This annual, which grows to about 2 feet, should be planted in full sun. It is a prolific reseeder.

In the next few years a number of hybrid impatience (*Impatiens*) with very striking foliage in bronze, red, gold and tricolor combinations will become available to home gardeners. They are being bred from species obtained from a recent U.S. Department of Agriculture expedition to New Guinea. Light shade is needed for impatience in the South, but in parts of the country where the summer sun is not severe, it may be grown in the open.

Pentapetes phoenicea, a plant with no common name, is a perfect companion for chrysanthemums. It grows to a bushy 4 feet by season's end. The lance-shaped, saw-toothed leaves are deep green with a tint of bronze. In late summer tall spikes of brilliant red flowers appear.

Tagetes 'Irish Lace', a marigold grown for its finely cut foliage, gives a cool, light green effect. Plants become perfect 8-inch mounds. (Southern gardeners, who have a long growing season, see 'Irish Lace' cover itself with tiny white flowers in October.) The same foliage effect, only in a taller version, can be achieved with summer-cypress (*Kochia scoparia* 'Childsii'). It makes a quick, temporary hedge, growing to 2 or 3 feet. Autumn foliage color is a glorious red.

Ornamental kale and cabbage have leaves with tints of rose, cream or white that become intense after a light autumn frost. Kale has typically crinkled leaves, cabbage, smooth ones. Both are best grown in parts of the country where only light freezes occur in autumn but they may also be grown in the North. If the growing season is long, as in the South, don't sow seeds of these plants before mid-June; otherwise they will grow too tall and leggy.

Decorative Fruit and Seed Pods

Ornamental peppers are not just florist pot plants for Christmas. They make neat little borders all season long and are covered with fruit from late summer to frost. 'Fips' is dwarfest, growing to 8 inches, and bears clusters of inch-long yellow rockets. 'Teno', to 10 inches, has a bouquet of cone-shaped, chartreuse fruit, which changes to orange and deep red. 'Fiesta' has slender, 2-inch long, bright red fruit. Christmas- or Jerusalem-cherry (*Solanum pseudocapsicum*) is equally suitable for borders. 'Cherry Jubilee', a compact 8 inches, is decorated with white and orange fruit in autumn. Both ornamental peppers and Christmas-cherry are as easy to grow as tomatoes and perform best where summers are long and warm. Start them indoors at least four weeks before the last average spring frost in your area.

Unicorn plant or martynia (*Proboscidea jussieui*) has 5-inch long, curved seed pods that split open when dried. All you need is a little paint, a few feathers, some wire, a few miniature spheres and your imagination to create a range of whimsical creatures, including dainty birds, fierce-looking spiders and prehistoric monsters.

Physalis alkekengi (*franchetii*), actually a perennial, grows little, bright red Chinese lanterns the first year from seed. Height: 2 feet. Stems are easily dried and last all winter. Put the plants in a separate part of the garden because they are rampant growers and can become invasive.

Jewels-of-Opar (*Talinum paniculatum*) has succulent green foliage. It grows to one foot. In late summer a cloud of dainty pink flowers opens in early evening. Later, bright red seed pods form on thin straight stems. They are attractive and, when cut, dry to a jet black.

Here is another unusual annual, the ornamental eggplant. It grows a foot tall, having typical eggplant foliage and small lavender blossoms. The fruits resemble white hen eggs and turn gold in autumn.

For Tall Screens

Shrubs require time to grow before providing privacy in the yard. If you have newly planted ones, simply include some tall-growing annuals in front of or among them and by midsummer a very effective screen is present. It is best to plant a double row spaced about a foot apart. Sow the seeds as soon as soil has warmed up in spring and danger of frost is past, or start them indoors. Some annuals are ideally suited for this purpose.

Hibiscus 'Red Shield' reaches a height of 7 feet. The maple-like foliage is a vivid dark burgundy-red with metallic luster. Plants take hot summer weather well and perform particularly well in the South. They are short-day plants and do not flower.

The Mexican sunflower, *Tithonia* 'Torch', has deep green foliage and brilliant orange-red, daisy-like flowers. The height is about 6 feet. While this plant can be grown in most areas, it does especially well where summers are long and warm.

Castor bean (*Ricinus*) is perhaps the best known annual for screening. It even becomes tree-like in frost-free areas. The large, palmate foliage creates a tropical effect. 'Zanzibarensis' is the tallest growing variety, to about 8 feet in most parts of the United States. It has green leaves. 'Sanguineus' has red foliage and red flowers. If young children are around, take care in planting castor beans because the seeds and leaves are toxic when eaten.

For Ground Cover

Several annuals spread quickly across the ground and can inexpensively carpet the garden by midsummer from a spring sowing after danger of frost has passed and the soil has warmed. In the North, some gardeners prefer to begin them indoors for a longer season. All grow to a circumference of a foot-and-a-half to 2 feet by July or August and last until frost. They are remarkably free of insect pests and diseases.

Polygonum capitatum 'Magic Carpet', an ornamental knotweed which is not as invasive as some of its kin, forms a dense mat of bronze foliage only 3 inches high. In October, when days get short, it is covered with small clusters of white flowers. The plant is often grown in southern California and other mild areas, but can also succeed in the North.

Creeping-zinnia *(Sanvitalia procumbens)* is a low-growing annual that forms a dense carpet 6 inches tall with yellow flowers.

An annual periwinkle, *Catharanthus* (*Vinca*) *roseus* 'Polka Dot', forms a dense mat of glistening deep green foliage covered with glistening white flowers and small red eyes. It is especially good for dry situations and performs best in hot sunny weather. *Sanvitalia procumbens* forms a dense carpet 6 inches tall. It is covered with small golden flowers in summer and resembles a creeping zinnia.

Portulaca Sunkiss is a new F_1 hybrid strain. Plants remain 6 inches tall and are more vigorous in lateral growth than other sorts of portulaca. It is truly a ground cover. Flowers are available in several colors as well as in a mixture. They stay open practically all day in cool, overcast weather. *Zinnia linearis* is somewhat taller, growing eventually to 10 or 12 inches. It spreads quickly and comes into bloom in late summer. The flowers, which are golden orange with lemon stripes, last through early autumn. Although it is a zinnia, it is much more rugged than the more common types and is practically free of mildew. ⁂

Two major planting seasons provide year-long color

ANNUALS IN CALIFORNIA

Philip E. Chandler

IN CALIFORNIA there are annuals for display every month of the year. At least this is true for the lower elevations of the southern two-thirds of the state where most of the population is concentrated, and therefore most of the gardens. In these regions there are essentially but two planting seasons—winter-spring and summer-autumn. The growing conditions are unique for the United States.

For Winter-spring Effect

The long winter-spring season is more-or-less cool and moist. However, dry spells occur even then, and santanas, the desiccating winds from the interior, come and go. One must always water, water. Planting for maximum effect of annuals in this season is best done from late August through October, for two reasons. First, seedlings should be in place while daylight hours are still fairly long and the ground is warm, or they won't reach blossoming size until nearly spring.

Also, many summer annuals are past their prime by September; gardeners are tired of the ubiquitous marigolds, and even ageratum becomes seedy. Daylight hours are already too short for more zinnias and China-asters. And homeowners begin to think of Christmas displays for which room must be made now. Perennial chrysanthemums, colorful everywhere in autumn, still have a long season, but these are increasingly grown in pots and whisked out of sight when past. Furthermore, in September, nurseries and garden centers are bursting with bulbs which make one dream of winter showers, rain-washed skies—and spring—even at this time, the hottest period of the year in southern California.

There is of course some loss from heat and drought, but annuals planted in September can flower from late October into May, provided the gardener places sun dwellers where the long winter shadows won't encroach. For continuous flowering, spent blossoms must be removed, frequent watering given, and fresh snail and slug bait kept in the garden. Completely successful planting for this period also requires porous, fast-draining soil. Raised beds are ideal in areas of heavy adobe soil, because there are winters when rain is almost incessant for several days at a time.

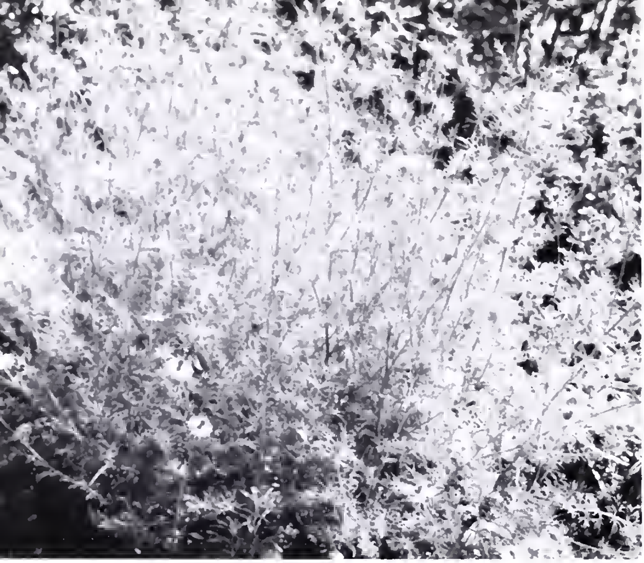
For gardeners who don't finish all their winter-spring planting by November 1, there are potted materials already in flower in nurseries. These furnish instant color but are relatively expensive and less long-lived than young plants set out earlier. Winter annuals can be planted as late as February, but they also perform briefly and often interfere with space needed for long-daylight subjects.

Any planting list for winter-spring display should include: Iceland poppy, which can be sensational for months and months; pansy; snapdragon; Siberian wallflower [*Erysimum asperum* (formerly *Cheiranthus allioni*)], which is rarely available; nemesia (also scarce but one of the best; annual phlox (good any season, and when one planting wears out, another can be added, even in the same bed, providing fertilizer and humus are renewed); summer- or cape-forget-me-not (some shade); calendula; *Dimorphotheca sinuata* (*aurantiaca*).

Also recommended are English daisy (*Bellis perennis*) and the group known as Monstrose Hybrids, both of which are usually annual in habit in California; several primroses, including *Primula malacoides* (shade), *P. obconica* (shade) and *P. polyantha*, which is often grown as an annual in light shade; cineraria (light shade), a prolific seeder of which the offspring run back to muddy magenta the second year; ranunculus and ane-

George Taloumis

Dimorphotheca is one of the annuals recommended for winter-to-spring display in California and other regions of the Southwest. Here it covers a slope in Scottsdale, Arizona.



The old-fashioned favorite love-in-a-mist (*Nigella damascena*) is another annual to be enjoyed in California's winter-spring season for its light blue flowers and delicate foliage.

mones, bulbous corms treated as annuals; annual candytuft (any season, after which it seeds forever and comes up in every path).

Most of these are available from nurseries as seedlings. Many others, such as the old-time garden favorite love-in-a-mist (*Nigella damascena*), blue laceflower or didiscus (*Trachymene caerulea*) and annual scabiosa, which becomes perennial here, can extend the palette if the gardener is willing to search through catalogs and start from seed. Some annuals will be lost to damping-off; others will seed themselves evermore. The tenacity of plants like sweet-alyssum causes such perfectly useful subjects to be classified as weeds in California.

For Summer-autumn Effect

Certain summer-autumn annuals begin to appear in nurseries in February—petunia, marigold, verbena, lobelia, ageratum and larkspur. They may be planted at this time or as late as July, except lobelia, which doesn't thrive in heat but flowers in long daylight hours. Lobelia 'Cambridge Blue' and 'Crystal Palace' are among the best blues for the lightly shaded garden. Along the coast lobelia carpets the ground from April through July and seeds itself in every direction, producing great variation of shades and tints, and occasionally a pure white.

At least one fairly dwarf marigold, 'Yellow Nugget', installed in late February, sometimes persists (if guarded from mites, slugs and wild canaries) until the following February. One is inclined to tire of this kind of annual—it's too easy for too long! Petunias often last two years and once in a while three—if cut back when stringy, but they rarely flower in Los Angeles from December to March. In Palm Springs, one of the warmest parts of the state, petunias are planted in full sun in late autumn for the winter season, but in summer they require some shade in that locale.

Classic hot-weather annuals, especially in coastal areas where real summer is usually delayed until July, are better not planted until May or later. Such annuals are the China-aster, annual dahlia (which becomes perennial if not discarded), celosia, Madagascar-periwinkle (*Catharanthus roseus*, formerly *Vinca rosea*) and zinnia, in its many forms and heights. All begonias and impatience are perennials in southern California but are often treated as summer-autumn annuals, especially the bedding types which are prone to nematode-infestation if left in the same bed more than one season. ⁂

The main difference is in the timing

ANNUALS IN THE DEEP SOUTH

James J. Franklin

NOT only is it possible to establish all annuals earlier outside, but the hardier kinds are started in the autumn and make considerable growth in winter during periodic warm spells. Later in the winter or by early spring these cool-season annuals have gradually developed from seed to strong, well-rooted plants. Favorable weather can result in December and January flowers in Florida, February and March color in other Gulf states. Good flowering over a four-month period can be expected from autumn-planted cool-season annuals, whether started from seed out-of-doors, in the house, or from trays purchased at a garden center.

Some of the best winter annuals, or kinds treated as such, are: baby's breath, browallia, calendula, California-poppy, candytuft, cornflower, gaillardia, larkspur, linaria, lupine, nicotiana, pansy, petunia, phlox, Shirley poppy, snapdragon, statice, stock, sweet-alyssum, sweet pea and verbena.

Seeds of the more tender (warm-season) annuals are planted any time of year in frost-free areas. In cooler parts of Florida and in neighboring regions they are planted from February through August. These kinds will flower from June until the end of the growing season, which may precede frost by many weeks (if any occurs).

Continuous removal of old flower heads and the setting out of some new plants at mid-season will help prolong the summer annual border. The real enemy of the summer garden, particularly toward the close of the season, may be frequent rainfall, making control of weed grasses and insects difficult; or it may be high humidity without rainfall, which increases mildew and other diseases to a destructive stage. Annuals were designed by nature to end their life cycle in seed production, but in rainy or very humid areas many do not reach this stage.

In various parts of the Deep South some warm-season annuals prove to be more satisfactory than others. Some of the best are: ageratum, China-aster, balsam, celosia, cosmos, crotalaria, cypress vine, globe-amaranth, gourd, marigold, morning glory, nasturtium, portulaca, sunflower, tithonia and zinnia.

For year-around success with annuals, the southern gardener must first know the difference in warm- and cool-season types. Zinnias and marigolds, for example, have come to our gardens from hotter climates and perform best in summer. Pansies, larkspur and calendulas evolved where a cool growing season existed, and they need a similar environment.

For excellent local information go to your county's agricultural center. Most of them have detailed bulletins or leaflets on this subject. ⁂

George Taloumis

A recommended winter annual for the South is browallia. It has bright blue flowers.

SEED CATALOG FIRMS

Burgess Seed and Plant Company, Box 218, Galesburg, Michigan 49053

Burnett Brothers, Inc., 92 Chambers Street, New York, New York 10007

W. Atlee Burpee Company, Box 6929, Philadelphia, Pennsylvania 19132; also Clinton, Iowa 52732; Riverside, California 92502

D. V. Burrell Seed Growers Company, Box 150, Rocky Ford, Colorado 81067

Comstock, Ferre & Company, 263 Main Street, Wethersfield, Connecticut 01609 (catalog 35¢)

DeGiorgi Company, Council Bluffs, Iowa 51501 (catalog 25¢)

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wood, South Carolina 29646

W. H. Perron & Company Ltd., 515 L
belle Boulevard, City of Laval, Quebe
Canada (catalog 50¢)

A cutting garden can be decorative as well as practical. Here annuals of one kind, such as forget-me-nots, zinnia and cosmos, are planted in blocks or beds and separated by flagstone-pave
paths.

eedway, Inc., Box 14123, Hall, New York 14463

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Arthur Yates & Co. Pty. Ltd., 90-100 Sussex Street, Sydney, New South Wales, Australia; also **Yates New Zealand, Ltd.,** P.O. Box 1109, Aukland, N.Z.

Note: In addition, many hardware and garden supply stores, even supermarkets, carry seeds from three major firms: Asgrow-Manville Company, Rochester, New York; Ferry Morse Seed Company, Mountain View, California; Northrup King Company, Minneapolis, Minnesota. ☙

George Taloumis

plant or two of petunia
n a small tub is all that
s necessary to transform
terrace into a garden.

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BROOKLYN BOTANIC GARDEN RECORD
PLANTS & GARDENS
Vol. 30 No. 3
(Autumn 1974)

DRIED FLOWER DESIGNS

A HANDBOOK

- How to Dry Flowers & Foliage
- Arrangements & Mobiles
- Craft Ideas & Projects
- Design Tips

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BROOKLYN BOTANIC GARDEN RECORD
PLANTS & GARDENS

DRIED FLOWER DESIGNS

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Georgia S. Vance
George Taloumis

Above **Mass arrangeme s** (see pages 20 and 64) e but one way to display dried plant materials. T s bouquet uses a variety of plant material from diffe ent seasons. Included ar roses and their foliage, daffodil, celosia, statice d zinnia.

Left **Astilbe** is a favori perennial notable for its long-lasting garden displ . It can also be air-dried (see pages 4 and 56) for use in dried arrangemen

LETTER FROM THE BROOKLYN BOTANIC GARDEN

Have you ever picked a bouquet of goldenrod for the table and marveled how long it lasts as a cut flower? Or yarrow, or a host of other common wildlings of the summer field? They are usually effective for a couple of weeks, which is rather good compared with the indoor stage time of most garden flowers. But that still leaves fifty weeks of the year unaccounted for! If you would like to learn how to dry or treat flowers and foliage for continuing enjoyment, then this Handbook is for you.

Our ancestors knew the art of flower drying very well. They had to, as Contributor Joan Parry Dutton points out, because there were few winter-blooming house plants to break the monotony of the long cold season of the year. By simply hanging certain flowers in the closet until dry, it became possible to enjoy them year-round.

The art of drying has had a marked revival in recent times. It has become a bit sophisticated because of new or refined techniques—and the wealth of different plants available to us today, but the principles are much the same as in Colonial times and can be quickly grasped by all who have roses in their hearts.

One needn't be an outdoor gardener to be smitten with this delightful art. Joe-pyeweed, mullein, Queen Anne's-lace and many attractive grasses can be found in vacant city lots, which are real treasure chests for the dryer. Apartment dwellers who grow such favorites as aspidistra, ornamental figs and strawberry-geranium will put these to work in new ways, too. By looking at plants through the eyes of the dryer, new dimensions in horticulture may be found.

Dried Flower Designs is one of the truly international Handbooks in the BBG series, thanks to Guest Editor Barbara Laking of Canada's Royal Botanical Gardens, and we are indebted to her for enrolling an all-star list of Contributors to share their experience with readers. Let this be an especially warm note of appreciation to one and all who have made this issue possible.

A final word perhaps on decoration. It is one thing to learn how to dry flowers but quite another to decide how to display them for best effect. Pay special attention to the timely pointers given by the expert flower arrangers in this Handbook and your pleasure in this pastime will be greatly increased. But whether your inclination is toward traditional or contemporary design, let the creative inner self emerge. As Contributor George Smith stresses: "Everyone has something new to give to this fascinating study, and the possibilities are truly limitless."

Try a few strawflowers this summer!

Frederick McGourty, Jr.

Editor

The basic principle of any drying process is the removal of moisture

AIR-DRYING–A SIMPLE METHOD OF PRESERVATION

Barbara Laking

THERE are many ways of drying flowers for artistic designs, and it is usually the form of the flower head that suggests the method. However, the majority of cultivated and wild-plant material can be dried by hanging upside down in bunches. This is called air-drying.

Flowers that are best suited for air-drying are ones that do not wilt readily, such as blue salvia, delphinium, goldenrod, larkspur, grains and grasses. These plants have long spiky types of flower heads with small blossoms on short stems. Dehydration causes shrinkage, but because the flowers are small and short-stemmed, placement and form are not affected.

Large flowers with many petals, in general the long-stemmed types, often wilt quickly after cutting and are not satisfactory for air-drying. Among them are carnations, cone-flowers, roses and zinnias. Such flowers are dried in silica gel.

Step-by-Step Procedure

- Cut the flowers on a sunny day, when they are dry and in peak condition.
- Select materials which are free from pests and diseases.
- Remove all foliage from the stems to hasten the drying process.
- Group the stripped stems into small bunches, tie securely with a rubber band and suspend head down on coat hangers. (See Diagram)

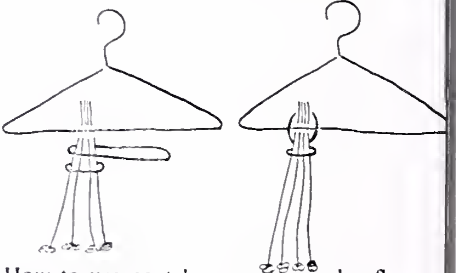
The drying area must be a location that is airy, warm, dark and dry, such as a furnace room, attic or closet. Some sort of overhead rack or pipe should be constructed for suspending the bunches of flowers on the hangers.

Some plants, such as sprays of baby's-breath, can be dried in an upright pos tion to preserve the natural fluffiness. Th method will induce interesting curvaceou stems in globe-thistle, poppy stems wit capsules, grains and grasses.

The average time through the variou stages of limpness until the stems sna readily and the petals are stiff to touc is ten days. Store the materials in a dr dark place.

Except for strawflowers (*Helichrysu bracteatum*), few air-dried plants nee wiring before hanging. Strawflowe should be picked in the bud stage. Th flower is cut off right below the hea A 20-gauge wire is inserted into th flower from below up through the cente The wire is then bent into a small fis hook and pulled back into the center the flower. The flowers are subsequentl tied into bunches, using a rubber ban and hung upside down from coat hanger The buds open quickly in the dryin area.

Globe-amaranth (*Gomphrena globos*



How to use coat hangers to air-dry flowers Wind the elastic around the bunch o stems twice. Put the stems behind th hanger. Pull the second loop forward, u and over the stems. Remove the bunc from hanger by pulling sharply down Elastic will remain in place around th bunched stems.

James C. Fish

Air-drying method for preserving flowers which are suspended from ceiling pipe on coat hangers. Flowers include larkspur, strawflowers, grasses, grains and blue salvia.

James C. Fish

Flowers of yarrow are suited to air-drying.

and rose-everlasting *(Helipterum roseum)* both have the tendency to droop their flower heads even after being thoroughly dried. Both should have their stems strengthened by the addition of wire and tape before they are used in designs. Although the majority of plants to be air-dried are gathered at peak flowering or leaf condition, interesting color variations can be achieved by gathering them at different stages of development. Curly dock *(Rumex crispus)* can be gathered at three stages: at maturity when green; later when a lovely pinky-rust color, and later again when it is a beautiful rusty-brown. Seed pods can also be gathered at the time their size, form and color are right for specific designs.

SELECTION OF PLANTS FOR AIR-DRYING

Garden Flowers

Baby's-breath	*(Gypsophila paniculata)*
Bachelor Button	*(Centaurea cyanus)*
Bells of Ireland	*(Molucella laevis)*
Chives, Leeks, or Ornamental Onions	*(Allium spp.)*
Cockscomb	*(Celosia cristata)*
Delphinium	*(Delphinium elatum)*
Globe-amaranth	*(Gomphrena globosa)*
Hydrangea, hills-of-snow type	*(Hydrangea arborescens* 'Annabelle')
Larkspur	*(Delphinium ajacis)*
Lonas, Yellow-ageratum	*(Lonas annua*
Rose-everlasting	*(Helipterum roseum*
Salvia, Annual Blue	*(Salvia farinacea*
Sea-lavender	*(Limonium latifolium*
Statice	*(Limonium sinuatum*
Strawflower	*(Helichrysum bracteatum*
Tansy	*(Tanacetum vulgare*
Winged Everlasting	*(Ammobium alatum*
Xeranthemum, Immortelle	*(Xeranthemum annuum*
Yarrow 'Coronation Gold'	*(Achillea* 'Coronation Gold'

Wild Flowers

Goldenrod	*(Solidago spp.*
Joe-pyeweed	*(Eupatorium purpureum*
Pearly Everlasting	*(Anaphalis margaritacea*
Yarrow	*(Achillea millefolium*

Leaves

See article on Preserving Foliage, page 11

Grasses

Bristly Foxtail Grass	*(Setaria verticillata*
Hare's-tail Grass	*(Lagurus ovatus*
Fountain Grass	*(Pennisetum setaceum* synonym: *P. ruppelii*
Pampas Grass	*(Cortaderia selloana*
Quaking Grass	*(Briza maxima*
Rattle Brome	*(Bromus brizaeformis*
Squirrel-tail Grass	*(Hordeum jubatum*
Ornamental Corn	*(Zea mays japonica*

Seed Heads

Cat-tails, Narrowleaf	*(Typha angustifolia*
Chinese Lantern	*(Physalis alkekengi*
Dock	*(Rumex crispus*
Honesty	*(Lunaria annua*
Iris	*(Iris spp.*
Lily	*(Lilium spp.*
Milkweed	*(Asclepias syriaca*
Mullein	*(Verbascum spp.*
Peony	*(Paeonia spp.*
Poppy	*(Papaver spp.*
Queen Anne's-lace	*(Daucus carota*
Rose Mallow	*(Hibiscus spp.*
Sea-holly, Oliver's	*(Eryngium oliverianum*
Teasel	*(Dipsacus sylvestris*

⁂

A step-by-step Procedure

PRESERVING FLOWERS WITH SILICA GEL

Elizabeth MacDermot

THE PRESERVATION of flowers is not new. However, new doors and windows are being opened through recently discovered or newly adapted materials that help to more perfectly keep our flowers.

Such a material is silica gel, a drying agent. In it are buried many kinds of garden, greenhouse or native flowers that could not otherwise nearly maintain their original form and color. This is a fascinating technique and you will find yourself striving for the perfectly preserved specimen—the rose which looks as if it had just been picked from the garden. Time and patience are required, but the method is fairly simple.

Silica gel is a chemical compound which has been used in industry for many years because of its ability to absorb moisture. A special mixture for flower drying, widely available now from florist and garden shops, contains a blue crystal indicator which loses its color when exposed to humidity. When silica gel is saturated with moisture after using many times, re-activate by placing it in shallow pans in an oven at 225° F. for several hours until blue color returns. Stir occasionally. It should be thoroughly dry and cool before you attempt to treat flowers with it. Keep the mixture in tightly sealed containers when not in use. The same silica gel may be employed for many years.

Preparations

Have all the equipment ready for use before you pick the flowers. This is what you will need: a large tray; sharp knife, scissors and wire cutters; florist wire of various gauges (No. 18 for thick stems, No. 23 average-weight for wiring, No. 26 lighter and No. 36 fine wire for delicate flowers); toothpick; florist tape (a roll of narrow wax, stretchy paper) in green and brown; white masking tape or freezer tape for sealing storage containers; an artist's brush for cleaning the flowers; tweezers for delicate work; an adhesive to replace or reinforce petals; plastic spray; facial tissues; various sizes and shapes of containers—cake and cookie tins, plastic ice cream cartons, coffee tins, shoe boxes and deep plastic trays. You should probably also have at least 5 pounds of silica gel on hand because it takes about a pound to cover one good-sized rose.

The ideal time to put flowers into the silica gel is as soon as they are picked, when they are in tip-top, crisp condition. The best results come from flowers cut at their peak, not when fully expanded and several days past their prime. Never pick after rain or heavy dew. Do not put wet flowers into the silica gel and avoid those with blemishes. Pick only as many as you have time to process. If not doing the flowers immediately, stand them in lukewarm water and put in a cool spot to condition.

The stem of the flower has to be removed in most instances. Except for plants with long, spiky flower stalks, such as those of delphinium, the stem is cut about an inch below the blossom. Most flowers are dried face up, and a false or natural stem, dried separately, is added later. Many natural stems do not dry well or are too brittle when dry.

Wiring

All flowers must be wired before drying. Whenever possible, insert the wire up through the piece of stem left attached to the flower. (*Fig. 1*) Push the wire up until it is embedded in the calyx. Leave an inch or so protruding from the end of the short stem. As the stem shrinks in the drying, the wire is held firmly. The gauge of the wire depends on stem size.

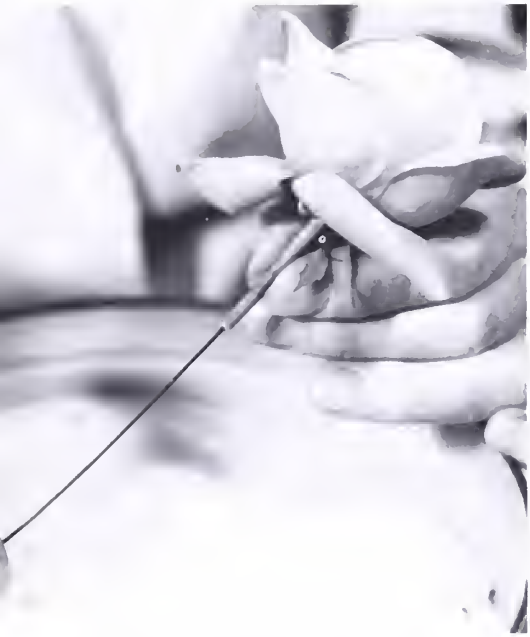


Fig. 1 Insert wire through piece of stem.

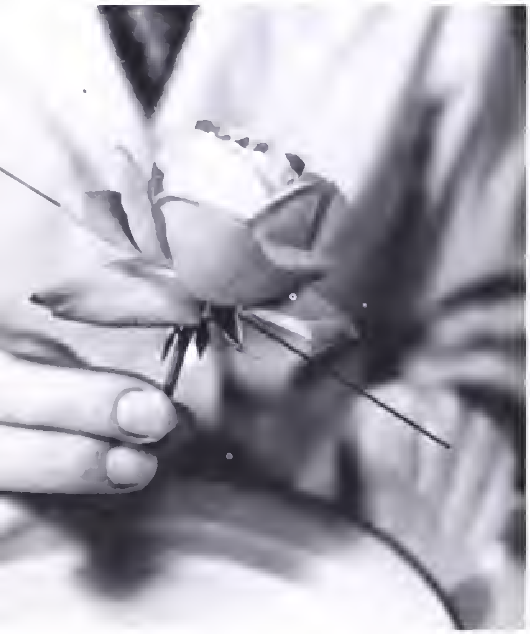


Fig. 2. Example of horizontal or cross wiring.

(*Fig. 2*) Horizontal or cross wiring is used when the stem is too delicate. Insert the wire through the calyx and fold it down parallel to the stem on each side. (*Fig. 3*) The hook-wiring method is used only when all others fail, because the small hook is apt to show as the flower dries. To hook-wire, the wire is pushed up through the entire calyx, a small hook bent and the wire pulled down so the hook is embedded in the center of the flower. This method is sometimes used with zinnias because their stems are too large and hollow to hold wire. Going to the other extreme, we use this method on some very delicate flowers. Freesias may be treated this way with a very fine wire. The hook does not show because it is deep in the small trumpet-shaped blossom.

When the wire is in place, turn it at right angles to the stem so the flower can be set upon a bed of silica gel at the bottom of the cookie tin or other container used for processing. The depth of this container depends on the size of the flower. When the flower is all 'set' in the container, begin covering with silica gel. It is best to have the container on a tray to catch any spill.

Application

Take a handful of silica gel (*Fig. 4*) and let it sift slowly around and under the flower. Sift gently over the blossom and lift the petals carefully with a toothpick so the gel works in well between petals: otherwise the flower will flatten. In double flowers work the gel between the petals, separating them gently with your fingers. In the case of a trumpet- or cup-shaped flower start building up on the outside, then put some inside the cup, keeping an even pressure on both sides so there is no danger of splitting the blossom or its petals.

Continue covering until all flowers are well buried. To insure this is so, lift container in one hand and tap it well with the other. As the silica gel sifts down the tips of petals may appear. Add more gel to cover. Cover the container, seal with tape, and label it, noting type of flower and date. Store in a dry cupboard.

For spiky flowers (*Fig. 5*) such as stock (*Matthiola*) two other methods are employed. Select a long box and cut supports of cardboard that will fit tightly across its width. Notch the center so the stem and blossoms may rest on the supports slightly above the bed of silica gel. Cover the whole stock the same way. *Fig. 6* shows a tall container with a flower head of stock. Remove most of the stalk below the blossoms. Again make a good bed of silica gel, hold the tip so the stem is upright, and fill in around the stalk until completely buried.

Most flowers dry in three or four days. Forget-me-nots, deutzia and other delicate flowers take less time. Fleshy flowers, including lilies and orchids, will take as long as a week. If small, more than one flower can be dried in a box providing they are of the same kind, but it is advisable to keep different kinds separate because of varied drying rates.

The florets on a hyacinth stem dry fairly quickly but the stems do not. Remove from the silica gel after four days and hang the whole raceme on a miniature clothesline until thoroughly dry. Roses may appear to dry within four days but a close look will often show the calyx still quite wet. If this happens, take the rose out of the gel and let it sit on top for a few more days. Be sure all flowers are completely dry before storing; one bit of moisture sealed in a box will ruin all of them.

Lift the box in one hand and tip it to the side, allowing the silica gel to fall into another container. Pour slowly and steadily; hold the other hand with fingers slightly spread apart over the edge of the container as the silica gel is poured, to prevent flowers from tumbling out. When the flowers appear, put two fingers underneath and gently pick them out as the silica gel is pouring off. Turn the flower upside down and tap the back of your hand so all the gel falls off. If some adheres, stroke the petals lightly with a small brush.

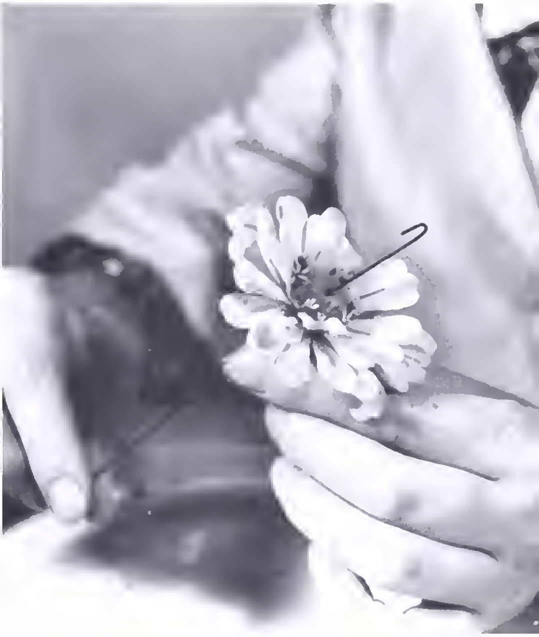


Fig. 3. Example of hook-wiring method.

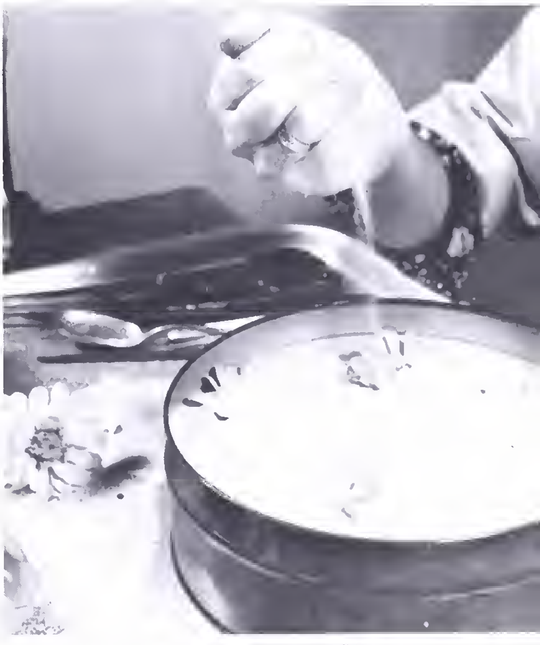


Fig. 4. Sifting silica gel around flower.

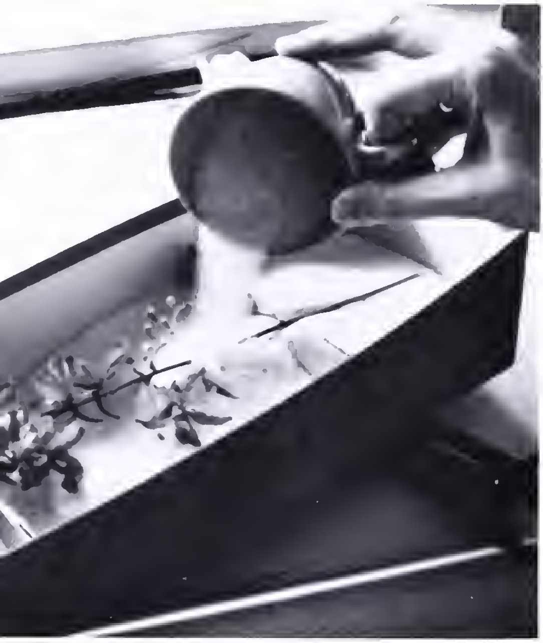


Fig. 5. Adding silica gel to spiky flower.

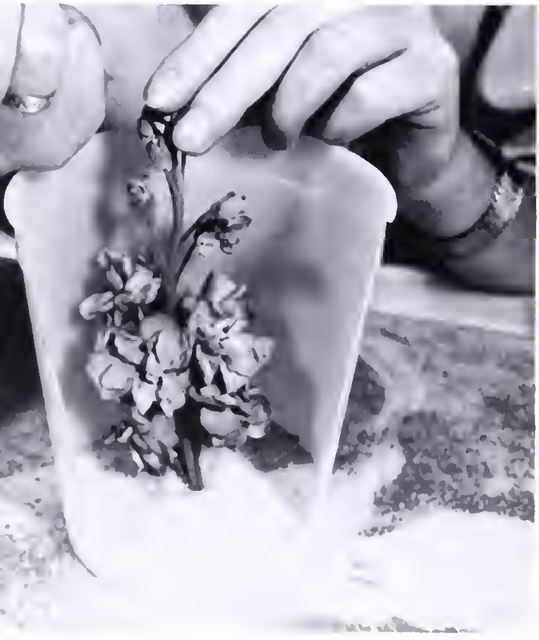


Fig. 6. Alternate method for spiky flower.

Is is sometimes advisable to reinforce the petals by dropping glue on their undersides near the stem and dropping small amounts in between petals of double flowers. Fallen petals can be replaced as well by gluing. Use adhesive that is clear when it dries.

A most important point to remember is that flowers treated with silica gel cannot be arranged successfully or left out of containers during wet and humid weather. All of them should be stored uncrowded in sealed, airtight containers (*not* in cardboard boxes) in a dry area during the summer months and arranged only in the autumn. Keep them away from humidifiers. Also, it is a good practice to put a few tablespoons of dry silica gel in the bottom of the storage containers.

Flowers preserved by silica gel are not everlasting. Don't expect them to carry over a second year, but if you would like to experiment, try a plastic spray on them. With luck you may be able to keep the flowers by again packing them away in sealed containers. However, there is always some fading of color.

Attaching New Stems

Basically, dried and preserved flowers are arranged in the same way as are fresh flowers, but the mechanics are different. False or substitute stems must replace fresh ones. False stems of florist wire are attached to the wired stem of the preserved flower with florist tape. This is quickly done with a little practice. Naturally dried or substitute treated stems can be added in the same way, but wired stems are easier to use in the arranging because they can be bent into graceful curves. However, some greenery should be added to obscure the stems.

One final tip about arranging—we employ dry floral foam (Oasis), cut to the size of the container, to hold the flowers Use new floral foam, since a piece that has been previously soaked in water does not hold as well. Dry moss is an appropriate and attractive cover for the Oasis. ❧

Preserved foliage provides a great variety of shapes, izes, textures and color

PRESERVING FOLIAGE

Katherine Cantlon

BECAUSE most flowers, and in some cases heir stems as well, are stripped of their wn foliage for the various drying proesses, foliage used in dried flower deigns is prepared separately and in quanity. Leaves which have a different drying ate from flowers may be preserved or dried successfully many ways.

Glycerine Method

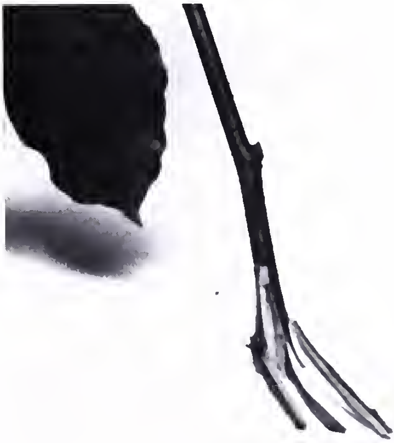
Many kinds of foliage from deciduous rees can be successfully preserved by his method and can often be used over and over again for years. Color changes occur from shades of green to almost black. Three-dimensional form is reained.

Select well-shaped branches with unblemished mature foliage. Generally, a branch about 18 inches in length is a good size; however, smaller ones, or arger ones up to 4 feet long, may be successfully preserved. Groom the branches by removing damaged leaves and wipe off debris with a damp cloth. Strip the leaves from the lower 4 or 5 nches of stem (see *Picture 1*). Woody stems should be crushed or preferably split with sharp pruning shears so the water-conducting tissue is exposed, enabling the stem to absorb the glycerine mixture more readily. The split at the base of the stem should be 1 to 2 inches long.

Make a mixture of 1 part commercial glycerine (available from many drug stores and florist supply houses) and 2 parts warm water. Stir vigorously, as the glycerine is heavier than water. Place 4 or 5 inches of the mixture in a clear glass container. (Glass containers are used because they are convenient for checking levels.) Mark level of mixture on the outside of the container with a waterproof pencil (see *Picture 2*). Place prepared branches directly into the glycerine mixture so the cut ends are covered.

Plants take up water faster than the glycerine in the mixture. Water is also lost by natural evaporation. As the mixture goes down in the containers it must be replaced up to the pencil line with a mixture of 1 part glycerine to 4 parts of warm water, or by the addition of warm water only. Check the level of the mixture frequently. Allow for circulation of air around the material, and don't crowd or cover the foliage. An ideal temperature is 75-80° F.

Inspect the progress of absorption of glycerine often. The time the branches should stand in the glycerine is variable —three days to three weeks. When the leaves' have reached saturation, an oili-



Picture 1 To enable the stem of the foliage to absorb the glycerine more readily, split it with a sharp knife or pruners. Then submerge split ends completely in glycerine.

Picture 2 With a waterproof pencil, mark original level of glycerine mixture. Be sure split stem ends are completely covered by mixture. Marking mixture level makes it easier to replace water lost by absorption.

ness is felt on their surfaces. Some leaves exude droplets of the mixture, and many will change color. The foliage should feel leathery and soft.

Remove the branches from the mixture and hang them upside down in bunches tied with string. Store them in a dry, dark place until needed for arrangements. Any leftover mixture should be stored in capped bottles for re-use. If mildew appears on the surface, skim and strain before storing. Darkening does not impair the effectiveness of the mixture.

Glycerine may also be used for processing, thick, waxy leaves, such as those of Boston-ivy and English ivy, periwinkle, hosta and lily-of-the-valley (see *Picture 3*). The same kind of mixture is employed. The foliage should be completely immersed in it for two to six days, until it feels soft and pliable. If preserving a lot of leaves, place weights on them to keep them under the liquid. Wipe the leaves and stems with paper towelling and drain them on newspaper until ready to use or store.

By exposing leaves treated in glycerine to various light intensities, interesting color changes will occur. Beech leaves stored in a dark dry place will retain their green or bronzed green coloring By placing some of the leaves in a sunny window for various lengths of time various shades of bronze to beige may be obtained.

Silica Gel

Some leaves may be successfully dried in silica gel and retain their color and form Among them are peony, delphinium and some ferns. The leaves are placed in a horizontal position in the silica gel. (See page 7 for more information on silica gel.)

Air-drying

Another method of preserving foliage is air-drying. This is accomplished by hanging, laying flat or standing. All air-drying should be done in an airy, warm, dry, dark place. Attics or warm basements are good areas.

Hanging. Some foliage, including the ghost-like leaves of artemisia 'Silver King', dries very well by hanging upside down in bundles. Unusual shapes are often obtained by treating the leaves of fiddle-leaf fig (*Ficus lyrata*), bird-of-paradise (*Strelitzia reginae*) and canna the same way.

Laying Flat. Foliage is placed on absorbent paper for two to three weeks. As it dries exotic shapes are produced. The method is useful for creating form and depth in designs with rubber plant (*Ficus elastica*), sea-grape (*Coccoloba uvifera*), castor bean (*Ricinus communis*) and aspidistra.

Standing. Foliage may also be dried by standing the stems in shallow water in a cup pinholder. The water is allowed to evaporate and the leaves air-dry. They will assume interesting free-form shapes and turn to brownish and beige hues. The leaves tend to be brittle and must be handled with care if treated this way.

Picture 3 The glycerine "bath" in which the glycerine is absorbed by the leaves and stems is used for foliage with long soft stems, such as ivy.

Pressing and Skeletonizing

Foliage to be pressed should be carefully spread out on several thicknesses of newspaper, or between pages of old telephone books. (Avoid shiny paper.) Do not overlap leaves, as they will tend to stick together. Cover with more newspaper and repeat for several layers. Place the pile on a flat hard surface and cover it with a piece of plywood and heavy weights on top. Use several bricks or a couple of 10 lb. bags of sand for weights.

Place the whole pile in a warm, dry place. Two or three weeks are needed for the pressing process to be completed. The newspapers should be changed for dry ones every day for three days. Then leave undisturbed until the foliage is stiff and dry.

Heavy-textured leaves may be very effectively preserved by skeletonizing. Color, form and texture are altered. The leaves to be skeletonized should be removed from the branches and placed in a solution of one tablespoon of sal soda to each quart of water. Boil them for 30-60 minutes, then allow to cool in the solution. Place them on a wooden board and gently scrape away the fleshy part of each leaf with a nylon brush until only the "skeleton" (veins) is left. Put the skeletonized leaves in a solution of bleaching agent consisting of 2 tablespoons of bleach to 1 quart of water, for about an hour. Remove them and rinse in cold water. The leaves, which will be ivory-colored, may be tinted in hot dye or sprayed with paint if a specific hue is required. Dry between sheets of absorbent paper. Press under weights.

Skeletonizing can also be done by boiling the leaves in detergent and water until all the fleshy part has separated from the veins. Allow them to cool in the solution. Dry between sheets of absorbent paper. Press under weights.

FOLIAGE TO PRESERVE IN GLYCERINE

Aspidistra	*(Aspidistra elatior)*
Bearberry	*(Arctostaphylos uva-ursi)*
Barberry, Chenault	*(Berberis x chenaultii)*
Beech, American	*(Fagus grandifolia)*
Beech, Copper	*(Fagus sylvatica* 'Cuprea')
Beech, Spaeth Purple	*(Fagus sylvatica* 'Spaethiana')
Cotoneaster	*(Cotoneaster spp.)*
Crabapple	*(Malus spp.)* Many cultivars
Currant, Flowering	*(Ribes aureum)*
Ivy, English	*(Hedera helix)* Many cultivars
Magnolia	*(Magnolia spp.)*
Mountain-ash	*(Sorbus aucuparia)*
Ninebark	*(Physocarpus opulifolius)*
Oregon-grape	*(Mahonia aquifolium)*
Peony	*(Paeonia spp.)*
Periwinkle	*(Vinca minor)*
Plum, Purple-leaf	*(Prunus cerasifera* 'Atropurpurea')
Poplar, Silver or White	*(Populus alba)*
Quince, Flowering	*(Chaenomeles spp.)* Many cultivars
Russian-olive	*(Elaeagnus angustifolius)*
Salal	*(Gaultheria shallon)*
Spirea	*(Spiraea spp.)*
Ti Plant	*(Cordyline australis)*
Weigela	*(Weigela spp.)* Many cultivars

Want to preserve the essence of a garden for year-round enjoyment?

POT-POURRI

Elaine N. Corbet

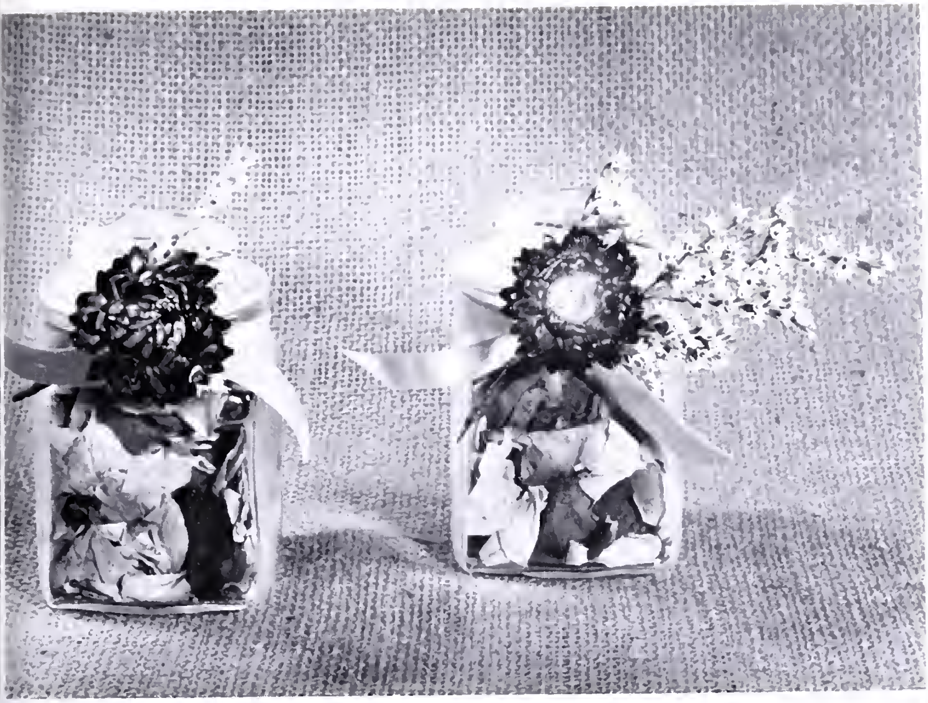
MAKE A POT-POURRI of rose petals. This is how it is done in the Floral Art Shop at the Royal Botanical Gardens in Hamilton, Ontario. Decorative nylon cloth (of the sort used in wedding dresses) or an apothecary jar serves as an appropriate container. If you decide to use cloth, which will disguise the ingredients, the rose petals may simply be air-dried on papers or a screen. Turn them frequently to speed the drying.

However, if the petals are meant to be seen, as in the apothecary jar, drying them with silica gel will give a much more attractive finished product. Place them in layers on a preliminary nylon net in the silica gel for easy removal when dry. Other small brightly colored flowers or petals may be added to the drying mix, too. In either method of preservation, air-drying or silica gel, pick roses from the garden only when dry.

Here is a recipe for pot-pourri. To on quart of dried rose petals add one cu of dried lavender blossoms. Mix in on tablespoonful of ground or sliced orri root *(Iris germanica florentina)* until th petals are coated. Next add 12 drops o rose oil, 6 drops of rose geranium and drops of any other oil or oils that ma appeal. Mix well after each drop. (*Editor's note:* pot-pourri ingredients may b obtained through the mail-order catalogue of Aphrodisia, 28 Carmine St N.Y., N.Y. 10014, catalogue $1; als Caswell Massey Co., 518 Lexington Ave N.Y., N.Y. 10017, catalogue $1.)

Pack the pot-pourri in a containe Cover tightly. Shake well every few day and allow it to mature for six week before putting it in the apothecary jar o decorative netting. Adorn with a ribbo and a few small air-dried blossoms.

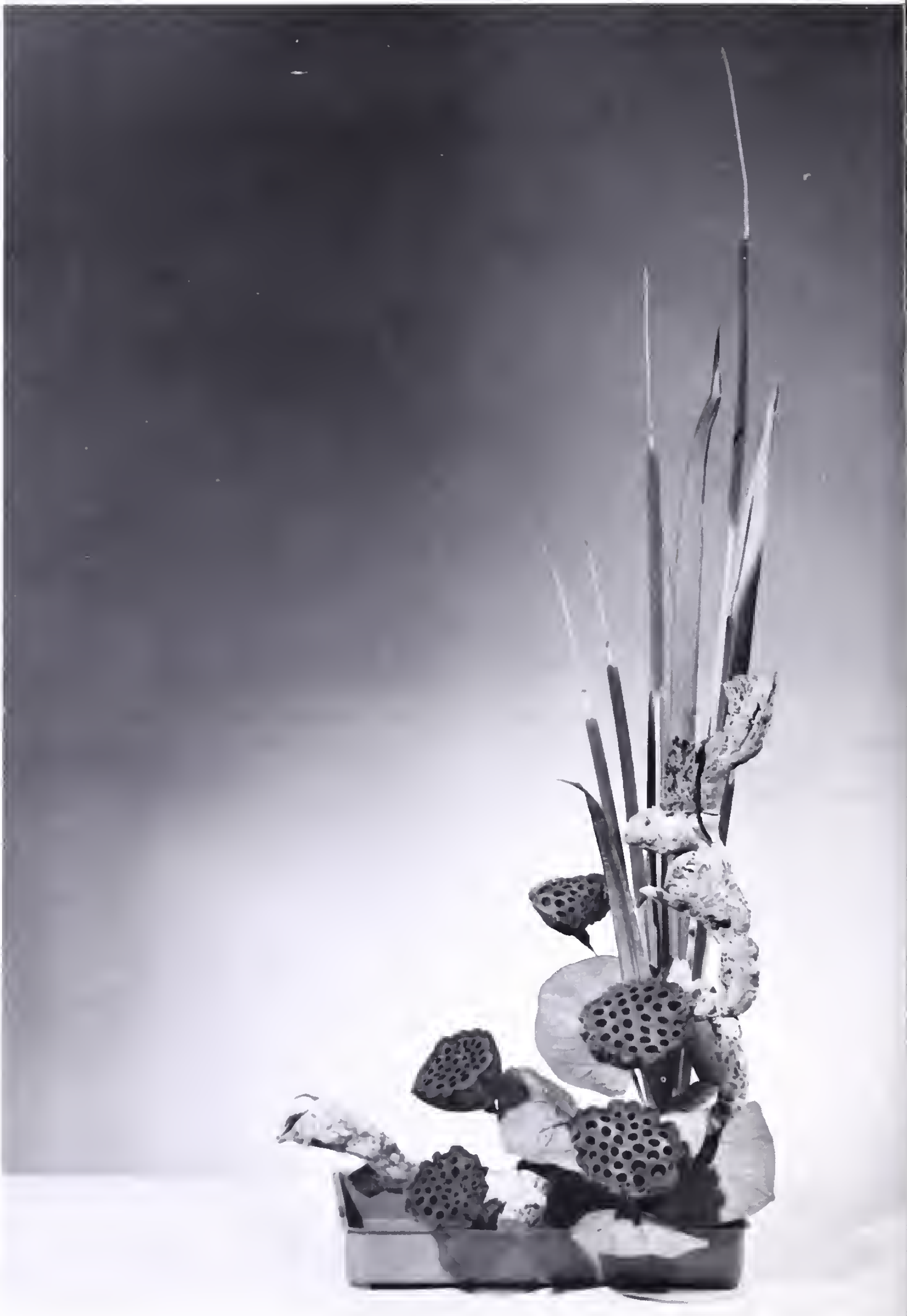
Pot-pourri enclosed in decorative nylon cloth bags. In this case, the rose petals do not show, so they may simply be dried by air method.



James C. Fish

Above Pot-pourri in nylon bag is decorated with bouquet of dried flowers.

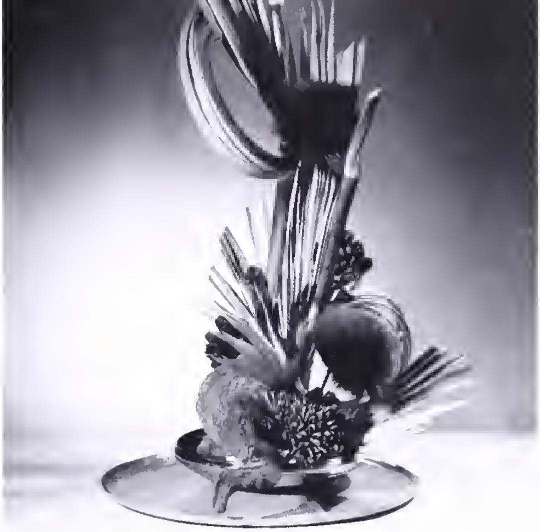
Right Apothecary jars of pot-pourri. Since the rose petals can be seen through the glass, they show more color if dried by silica gel method than by air-drying.



Warren Jepson & C

Stressing design Contrasting plant forms stress the need for points and rounds in a desig
The interesting driftwood is dried reed root. Bullrushes, lotus pods and hau leaves make
simple but effective decoration in a terra cotta plastic tray.

Excitement in Three D Dried palm shoots curved and secured by wire, create a dramatic effect. Two vivid cardoon pom-poms draw attention while agave clusters and driftwood help to add weight at the base of the design. The container is a shallow copper bowl. The materials are inserted in a pinholder secured by floral clay or similar product.



More freedom with perishable materials

DESIGN WITH DRIED AND TREATED PLANT MATERIAL

George W. Smith

Design is possibly the most important element of any visual form of artistic expression, of which flower arrangement is no exception. The need for a design plan or pattern is common to all creative minds. It gives to the individual the ability to transfer a desire for self-expression into a coherent whole. Once the ability to control form, color and texture within a pattern has been mastered, we have discovered the power to communicate our ideas to others through design.

Dried and treated plant materials provide far greater scope than fresh materials, for the designer can be unhampered by the restrictions and ephemeral quality of a perishable medium. By shaping and pruning, steaming and wiring, reforming and recreating new forms from old, we have control over each element of the design as it progresses and can take as much time as is necessary to produce the finished design.

All designs must conform to some limits. The most important are function and setting. Let suitability be the most important consideration, and ask yourself what the purpose is of a particular design and where it is to be positioned. Almost always it is better to begin with the setting, for here many guidelines will be found. Size and scale will be set by the boundaries of position. It is always helpful to take exact measurements, especially if the decoration cannot be created *in situ*—a method I prefer whenever possible.

Take into account from what angles the arrangement will be viewed, on what it will stand, how much light, heat and humidity it will receive. All these have considerable bearing on the finished design. Remember, simplicity is often more effective than an overly extravagant creation, especially if the setting is already crowded with beautiful objects.

Style will be dictated by the limitations of the setting and by the necessary function of the decorative piece, such as a slender vase at the turn of a staircase, or a narrow console table in a busy passageway. Thinking all this out before

A minimum of dried plant material—artichoke flowers, cat-tail foliage and an intricately curved piece of driftwood—has been used in this arrangement.

we begin will save needless disappointment later. But the style of design is also influenced by general décor and it is especially important to have some feeling for the general mood of the setting. As the effect we are trying to achieve is one of harmony between floral design and its environment, then we must also have an awareness of what goes with what. This is that indefinable quality called "good taste"—and something we all see from different points of view influenced by background, personal preference and artistic awareness.

The setting will suggest the choice of container and style of design, be it contemporary or of an historic period. The mood of the design must also portray and reflect the feeling of the setting, which can be rustic or sophisticated, primitive or grandiose, elegant or everyday. Lines, forms and textures all communicate visual impact and can express these ideas to complement the setting.

The choice of plant material is limitless, but is admittedly governed by funds and by availability. A good dried-flower arranger can be likened to a good cook, for both should have a well-stocked larder of ingredients. The collecting, harvesting and storing can become a most absorbing aspect of the art. The necessity to make frequent inspections of one's stocks to ward off the depredations of humidity and possibly vermin can lead to an almost miserly accumulation of floral wealth. Good storage is of paramount importance, as pointed out elsewhere in this Handbook.

Forms and Techniques

Our designs may take many forms, including swags and garlands, wall plaques and collages, and pressed flowers and leaves mounted under glass. A wide variety of containers for free-standing designs can be used because there are no limitations created by the need for water. Any object which fits the setting may be selected.

Techniques will vary in the assembly of each design, but the semi-permanent nature of the decoration does dictate that all should be firm and secure. Floral clay, polystyrene and dry Oasis all make good foundations with needlepoint holders for extra ballast. Very fine gravel or sand may be used to fill large containers to neck level. A small cradle of one-inch mesh chicken wire will give extra support to cover the opening. Florist wires will be necessary in a variety of gauges and lengths for mounting up individual items into sprays and to strengthen weaker stems. Scotch tape can be applied to the back of leaves to hold the wire in place. Neutral colored self-adhesive florist tape will be useful for covering wired stems. It should be in fresh condition when purchased and should still retain its rubbery elasticity.

Expert observation and some inventiveness, backed by practice, will give confidence to the arranger. Don't be disheartened if you feel dissatisfied with your first attempts, for it requires a good deal of patience to master the technique of wiring and mounting up flowers, foliage and seedheads. Two general rules are to avoid using an unnecessarily heavy florist wire and never to twist wires around each other. Wires are always bound together by fine reel wire in the case of a swag or by gutta-percha tape for a small light spray, such as one of skeletonized magnolia leaves.

Whatever the design with dried material, try to work *in situ* if at all practicable, as this gives a much better overall impression of the finished effect and saves the frustration of adjustments once the decoration is complete. It is so much easier to view the effect as it progresses when actually on site.

Bear in mind the durability of each item selected—for instance, flowers preserved in silica gel cannot stand up to a damp atmosphere and are best reserved for centrally heated rooms. Material which has been preserved by a solution of glycerine may tend to deteriorate by absorbing surplus moisture from the atmosphere, causing mold to set in in damp conditions. However, its added pliability and attractive texture tends to make up for this trait.

Experiment with colored materials. In moderation the richer brown, russet, orange and tan effects achieved by the inclusion of dyed materials may do much to offset the monotones of dried material. Plant dyes are frequently added to glycerine solutions and produce a remarkably life-like effect; an example seen recently was green food coloring used in a glycerine solution for ivy—the preserved ivy instead of being dark brown was indistinguishable from freshly picked ivy, as both texture and color were preserved. (See Brooklyn Botanic Garden Handbooks 46 and 76 for information on dyeing with natural plant materials.—*Ed.*)

In conclusion, try always to create something of oneself. To copy the designs of others may be good practice but will never compare with the satisfaction achieved by an original creation. Everyone has something new to give to this fascinating study, and the possibilities are truly limitless. Enjoy what you make and others will feel your pleasure and draw inspiration from your designs. ✤

A swag in the manner of a Grinling Gibbons wood carving, incorporating varied forms of dried leaves, flowers and fruits.

Dried plant materials are uniquely suited to this type of arrangement

THE MASS ARRANGEMENT–ITS DESIGN AND MECHANICS

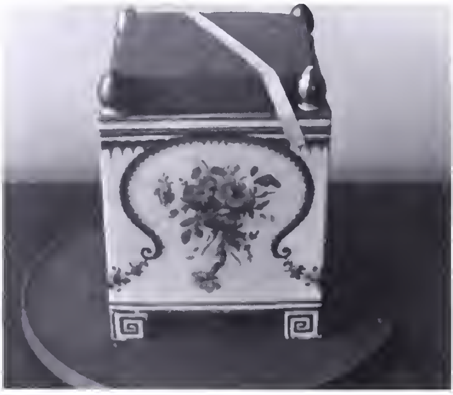
Georgia S. Vance

MASS ARRANGEMENTS stem from the European bouquets of various historical periods. It is probably the flower paintings of the Dutch-Flemish artists that have most influenced flower arrangement in the West to the present day. They were masterly compositions in the baroque style with swirling movement and broken rhythm, sweeping lines, a feeling of depth, contrast of light against dark, balance-counterbalance, dramatic use of color with a salient feature—the lazy S-curve.

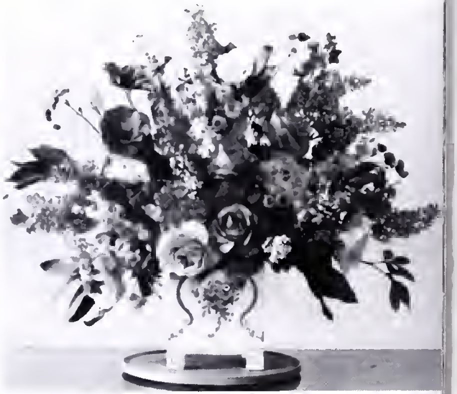
Exuberant masses of exquisitely painted flowers were uncrowded and loosely disposed to provide nodding room in the characteristic oval form which usually overpowered the handsome container. Large as well as dainty flowers were conspicuous in the silhouette with a dramatic form often placed off-center at the top.

Artists imparted a special character of their own to the baroque—a character to suit the taste and temperament of the country and period. Jan van Huysum's paintings, for example, were grandiose and splendid to suit the taste in Holland in the first half of the 18th century. A about the same time, his brother Jacob went to England and in his paintings we see that classic restraint has modified designs to suit the English taste of the early Georgian period. It is also interesting to see how the Flemish artist Jean-Baptiste Monnoyer adapted the baroque to make it French and acceptable to the court of Louis XIV. His flower paintings possessed elegance, lightness, grace and subtle color harmony.

The popularity of the baroque styles spread to all parts of the Continent and to the Americas. The Colonial Georgian period in this country yields little information on flower arrangement but the

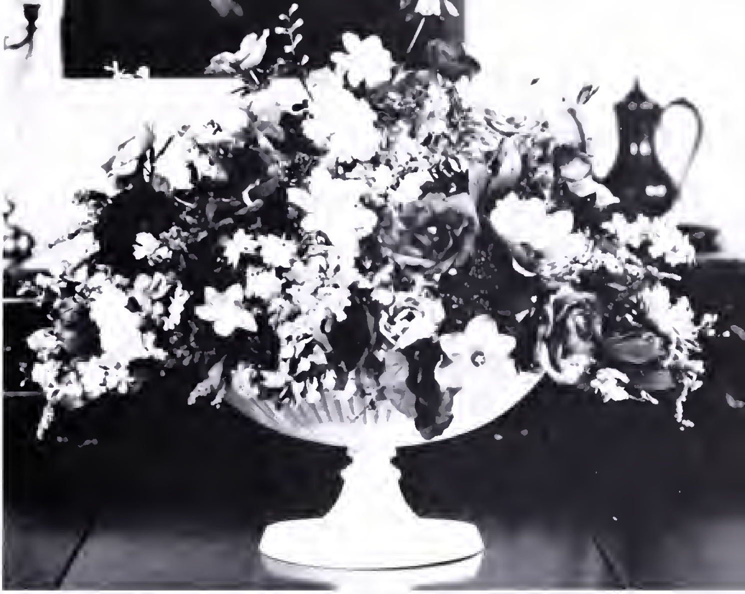


Preparing the container so it securely holds the dried arrangement. The floral foam extends above container to give additional surface so stems and wires can be inserted from any direction.



Completed mass arrangement after outline of design has been determined. Sprays of deutzia and little chrysanthemums give variety and contrast and are added to arrangement last.

'he completed form of his bold, bright mass rrangement shows symnetrical balance, good roportion and shape to ts setting. Among the nany dried flowers used re columbine, daffodil, lelphinium, rose, statice nd larkspur.



Arrangements and photographs by author

English influence was no doubt felt. Even Benjamin Franklin advised his wife to follow the latest London fashions in home furnishing and decoration.

The architecture and furnishings of this period are highlights in the history of American art and make it the most popular revival style. Public buildings and houses of historical significance have been authentically restored and furnished and opened to the public. Others have been restored and adapted for modern living by many families. Fine antique furniture and furnishings are collected and cherished and reproductions, too, are used everywhere. For rooms in this early 18th century tradition it is indeed a challenge to adapt the baroque style to suit the taste of today.

Mass arrangements of dried and treated plant material can be created in many styles and have unlimited uses as decorative pieces. In an early American room, a casual bouquet of field flowers in a stone jar is lovely on a window sill. For a formal living room with Sheraton, Hepplewhite or Duncan Phyfe furniture a dignified triangular design of slender proportions and cool colors might be arranged in a classic urn.

In many homes, styles are mixed, giving the arranger an opportunity to bring a fresh and different interpretation to the mass arrangement, either traditional or modern in feeling, depending on the material selected and the intent of the arranger. Many possibilities also present themselves for Victorian styles. It is a most comfortable feeling to have a dried flower arrangement on hand for the dining table—a decorative centerpiece beautifully coordinated with other appointments.

Design and Mechanics

Dried arrangements can be enjoyed over a long period of time. Of course, as with any flowering arrangement, they should be created to complement the setting in style, color and mood, and be suited to the space they will occupy in size and shape. Mass arrangements are composed in three-dimensional geometric forms—spherical, conical, triangular, rectangular, crescent and oval.

Grooming and cosmetic treatment will present each dried or preserved flower at its best A dropped petal can be replaced with glue. Residue or dust can be removed with a camel's hair brush or by "sandblasting," accomplished when a fine stream of sand is made to fall on a flower from the hand held about 18 inches above it, the striking grains carrying the residue with them as they bounce off. Glycerine-treated foliage can be polished to a high sheen with a soft cloth or paper towel. Some air-dried material, such as plume celosia, must be subjected to steaming to restore its natural, graceful, feathery appearance.

Flower Shapes

A delightful bouquet can be made using one kind of flower—a bowl of roses with rose foliage. A mass arrangement of mixed flowers requires material of different kinds, shapes, textures, sizes and patterns: *Rounded form* flowers are center-of-interest types, for they attract and hold attention. They include roses, lilies, dahlias, zinnias, peonies, camellias, daisies, and also rounded leaves. *Spike forms,* such as delphinium, larkspur, grains, grasses, salvia and fern fronds, give airiness to the silhouette. *Elongated spray forms,* such as goldenrod, dock, lilac, plume celosia, nandina berries, and branches of foliage with slender leaves, are transitional between spike and rounded forms. *Cluster forms* serve in dried arrangements as "filler" material to provide density, and include hydrangea, pearly everlasting and boneset. *Contrasting forms,* small flowers of interesting shapes, contribute to the vitality of arrangements. In this group are feverfew, helipterum, love-in-a-mist, verbena, pansies, daffodils and columbine. Compatibility of flowers and foliage must be considered because in most cases they are preserved separately.

The mechanics involved in making an arrangement of dried and treated plant material require special supplies and tools. Floral foam (used dry) has proven to be an excellent means of holding flowers and foliage in the desired position, supporting all but the heaviest material adequately. Fragile stems and wires are easily inserted and held firmly. It can be cut and shaped with a knife to fit snugly into a vase. A narrow strip of tape (strapping tape, adhesive tape or t florist's Davee tape) placed across t foam and fastened over the rim of t container will keep it well anchored. Tv strips placed at right angles will hold block of foam securely in a wide-mouth container or bowl. Floral foam sold und such trade names as Oasis or Quickee available in large bricks and small cyli ders.

Large Arrangements

For large arrangements of heavy m terial with large stems, it is advisable use dry sand in the lower two-thirds the container for weight, and Styrofoa in the top-third of the container to ho the stems securely in position. The Styr foam should rest on the sand, and exter above the rim of the container to provi additional surface into which the ster can be inserted from any direction. Tw strips of tape placed at right angles w hold the Styrofoam securely in a lar container. Styrofoam is available in cyli ders, bricks and large sheets.

Wire is needed to extend stem leng and strengthen fragile stems—24-gau for small flowers and 18- or 20-gauge f heavier kinds. Chain-nosed wire cutte of the mechanic's pliers type are usef not only for cutting wires without ben ing, but also as forceps for placing extracting flowers when arranging. Flor tape in green and brown is used to cov wires and also to bind together wires a stems when increasing the stem lengt These items can be purchased from flor shops, garden centers, hardware stores specialty shops.

Ideally, flowers would appear in dri arrangements on their natural stem Where wires have been substituted duri the drying process some means of ca ouflage should be found. Attractive dri hollow stems and those with spongy i teriors are the answer—larkspur, prince feather, celosia, globe-amaranth, day-lil hydrangea. It is just a matter of slippi the wire through the stem and fasteni with floral tape.

Enchantment from small things

MINIATURE DRIED AND PRESERVED FLOWER ARRANGEMENTS

Lois Wilson

THE EYE AND THE HEART have always been enchanted by the wonder of small things—small plants, small leaves, small flowers and seeds no less than inanimate tiny sculptures, toys, paintings. To learn, through simple techniques of drying and preserving, the art of prolonging their fragile beauty in miniature flower bouquets is a special enchantment, easily taught, easily learned. And the ultimate pleasure is one to be cherished by all kinds of people.

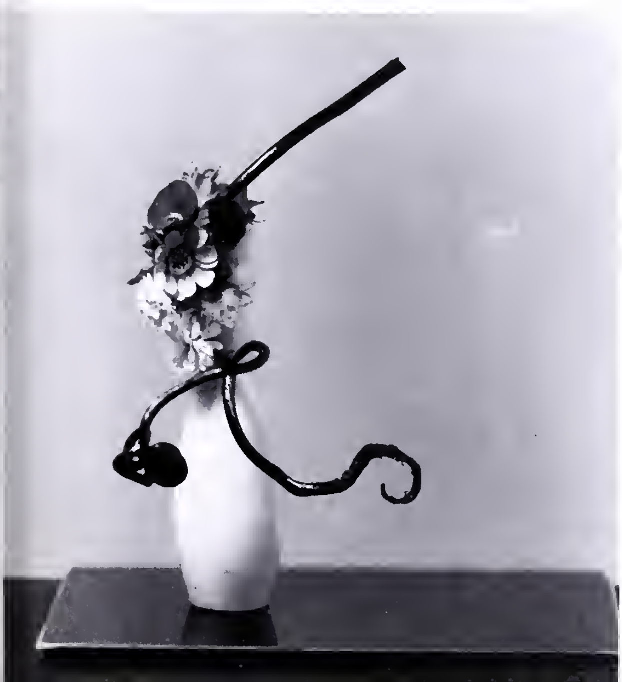
Teachers of young children believe, and have proved over and over again, that miniature flower arranging is one of the finest ways to teach boys and girls a love of beauty, especially of the common growing things in the world around them. Through the gathering, the handling of the materials, they learn at first hand the beauty of a weed, the miraculous precision of the structure of a tiny cone.

As therapy for the elderly, the chronically ill and handicapped, working with miniatures is both entertaining and practical. It demands no involved training for teacher or volunteer. It uses little material, most of it costing nothing. It takes little space to transport and only a small table or a few square feet of bedspread to lay out. It's neither heavy nor awkward and the finished arrangement asks nothing in the way of care but a gentle puff of air to keep the dust off.

In flower shows it's the miniature classes that attract the crowds, perhaps unknowingly moved by the same mystery the poet Tennyson wrote of in "The Little Flower in The Crannied Wall":

Little flower, if I could understand,
What you are, root and all,
And all in all,
I should know what God and man is.

For the arranger of miniatures, whether to compete in shows or to make for pleasure and decoration in her own house,



Miniature dried arrangement in an Israeli vase. Plant material includes a piece of grape vine, cornflowers, buttercup and crown of thorns and feverfew.

there is immeasurable delight. Nature's world now has a new dimension.

The Making

Bud, twig, tendril, flower, leaf, cone and seed are all on the list of possible supplies of plant materials. The world overflows at almost every season with things to use. In gardens, you can deliberately plant such little beauties as the deep blue alpine forget-me-not, tiny violets and thyme with its glossy-leaved stems. In woods and fields, varnished yellow buttercups and little pink-striped bells of dogbane *(Apocynum)* can be gathered. Even in unlikely places like highway boulevards and ditches, railway banks and vacant lots, there are such intriguir things as spires of yellow and white swe clover and, in the autumn, little seedlir dandelions that, pressed, make snowflak and stars for Christmas windows.

For outline and vertical emphasi nothing is more versatile than sedges ar grasses and tendrils of wild vines lik grape and bittersweet that scramble ov country fences. For foliage, there are bi of newly sprouting fern; the miniatu little broad-leaved evergreen, *Eunoym fortunei* 'Kewensis'; the easily manipulated stems of broom *(Cytisus)*. Th sturdy evergreen Blaauw juniper (a ga den variety of *Juniperus chinensis*) is special treasure for Christmas-tree shape

SOME FAVORITE DRIED OR PRESERVED PLANT MATERIALS
FOR MINIATURE ARRANGEMENTS

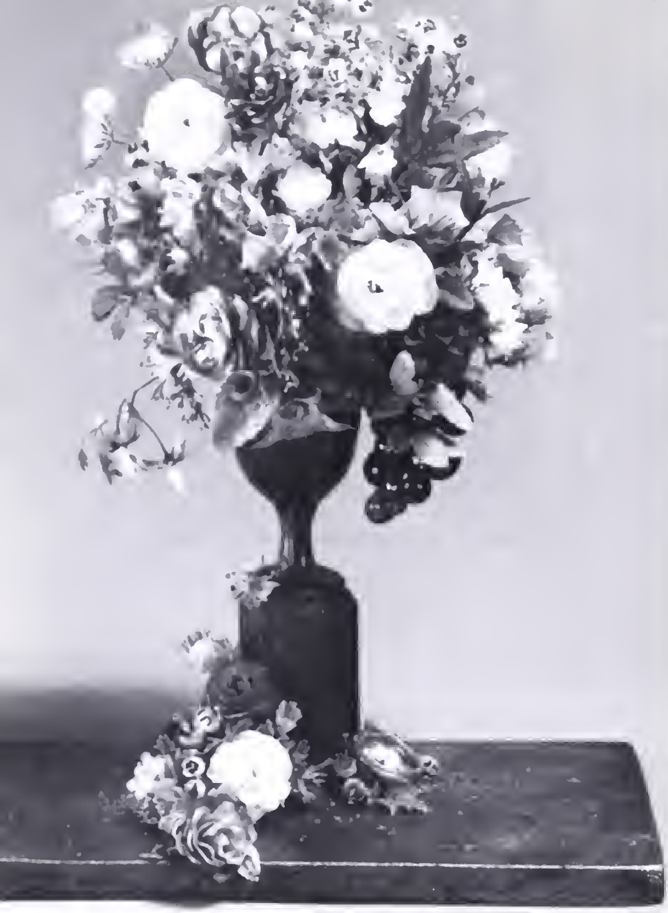
Evergreens	Box	*(Buxus spp.)*	for small foliage
	Broom	*(Cytisus spp.)*	for line
	Euonymus	*(Euonymus fortunei* 'Kewensis')	small tips and foliage
	Ivy	*(Hedera spp.)*	small tips and trailing stems
	Periwinkle	*(Vinca minor)*	for tips and trailing stems
Trees	Birch	*(Betula spp.)*	for buds, tiny catkins
	Corkscrew Willow	*(Salix matsudana* 'Tortuosa')	fascinating branches
	Hawthorn	*(Crataegus spp.)*	small flowers
Vines	Bittersweet	*(Celastrus spp.)*	for twining vines and orange to red fruits
	Clematis	*(Clematis spp.)*	for twining vines
	Hydrangea	*(Hydrangea petiolaris)*	for dainty flowers
	Grape	*(Vitis spp.)*	for tendrils
Shrubs	Barberry	*(Berberis spp.)*	for foliage
	Heath	*(Erica spp.)*	for tiny bell-like flowers
	Spirea	*(Spiraea arguta)*	for foliage
		(Spiraea pruniflora)	for foliage
Perennials	Artemisia	*(Artemisia albula* 'Silver King')	fine gray-white foliage
	Baby's-breath	*(Gypsophila spp.)*	for flowers
	Coral bell	*(Heuchera spp.)*	for little bell-like flowers
	Forget-me-nots	*(Myosotis spp.)*	for tiny blue and pink flowers
	Blue Fescue	*(Festuca glauca)*	beautiful stony turquoise
	Lavender	*(Lavandula spp.)*	for fragrant blue flower heads

For berries, the scarlet of holly and barberry keep well if rubbed with salad oil; the ivory fruit of the Russian-olive *(Elaeagnus angustifolius)* needs no treatment; clusters of black-berried privet look like luscious bunches of hothouse grapes. For seed pods and cones, there's the prickly cap of beechnuts and the smooth one of acorns; the intricately made tiny cones of hemlock, larch and casuarina; and one of the most fascinating of all, the candelabra seedheads of the common little roadside weed, herb Robert *(Geranium robertianum)*. From greenhouse and florist there are the handsome orange-red blossoms of crown-of-thorns and little stars of kalanchoe; tip growth of any of

Some of Mrs. Wilson's miniature containers.

Perennials (Continued)	Ornamental Onions	*(Allium spp.)*	dried flower heads (individual florets)
	Sea-lavender	*(Limonium latifolium)*	for minute flowers
	Thrift	*(Armeria maritima)*	little clover heads, pink
	Thyme	*(Thymus spp.)*	good flowers and foliage
	Yarrow	*(Achillea tomentosa* 'Aurea')	gray woolly leaves, yellow flowers
Annuals	Annual Phlox	*(Phlox drummondii* 'Twinkle')	many colors available
	Cockscomb	*(Celosia spp.)* Plume or feather forms	many colors available
	Creeping-zinnia	*(Sanvitalia procumbens)*	yellow daisy-like flowers, purple centers
	Globe-amaranth	*(Gomphrena globosa)*	white, pink, purple clover-like flowers
	Sweet-alyssum	*(Lobularia maritima)*	white, pink, deep lavender flowers
Florist's Plants	Creeping Fig	*(Ficus pumila)*	small leaves
	Ivy	*(Hedera spp.)*	small leaved cultivars
	Miniature Roses	*(Rosa spp.)*	tiny flowers, many colors available
	Strawberry-geranium	*(Saxifraga stolonifera)*	marbled leaves
Wildflowers	Check conservation list before picking.		
	Buttercup	*(Ranunculus acris)*	yellow flowers
	Club Mosses	*(Lycopodium spp.)*	club-like spikes or "candles"
	Goldenrod	*(Solidago spp.)*	yellow flowers
	Pearly Everlasting	*(Anaphalis margaritacea)*	white flowers
	Queen Anne's-lace	*(Daucus carota)*	white flowers
	Tansy	*(Tanacetum vulgare)*	yellow flowers

Any seed pods in good scale for miniature designs.



Miniature dried arrangement in black bone cup bought in Portobello Market in London. Its stand is a sawn-off dental-floss bottle. Bird's nest at base is made from author's hair, the eggs from stripseal painted wit green nail polish. Plant materials include coral bells, double wax begonias, heather, pearly everlasting, nightshade and variegated ivy.

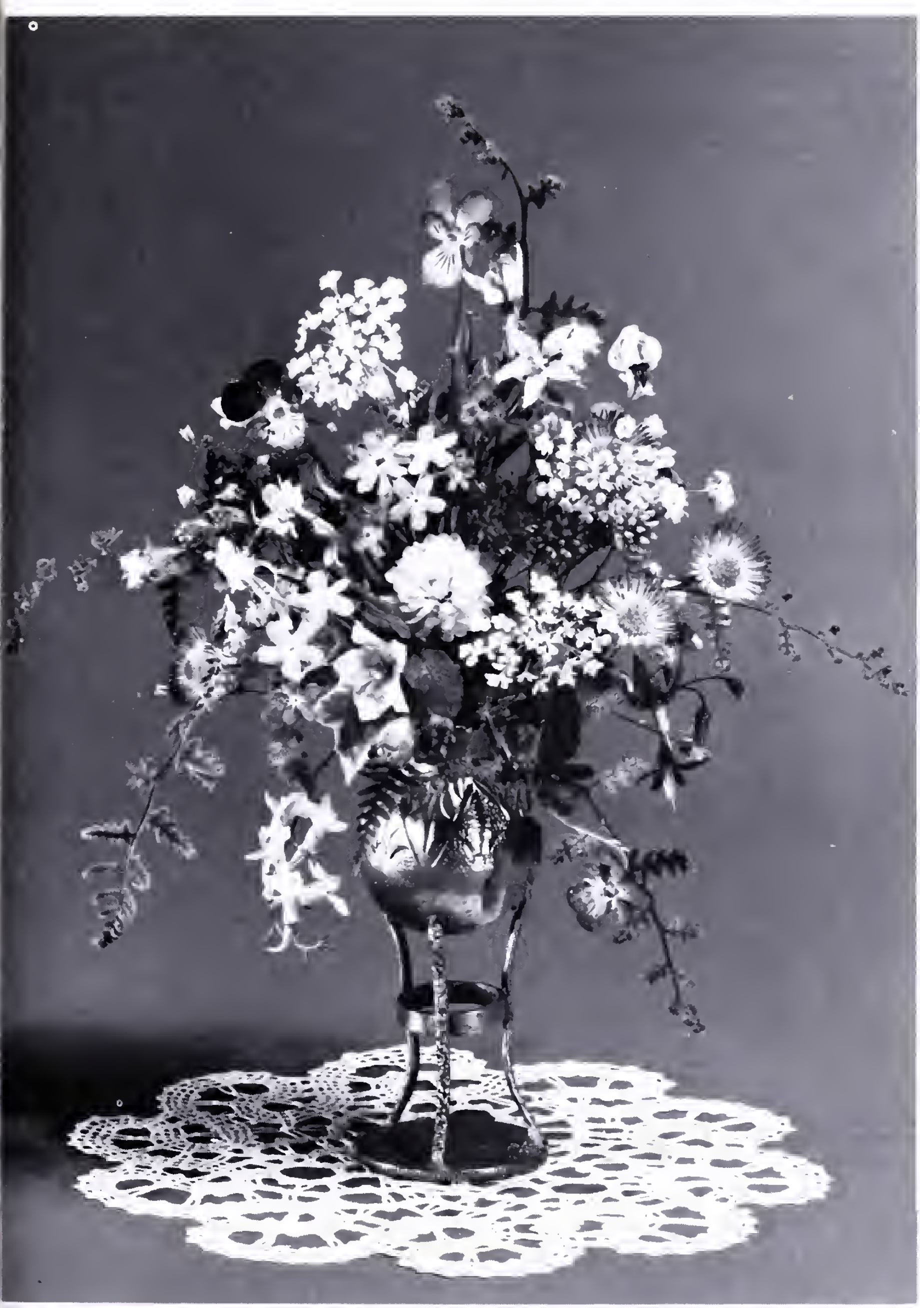
the small ivies, the pink of strawberry-geranium leaves.

All of these plant materials dry superbly in silica gel (see page 7). Pick them as they come into bloom, dry them and if they are not to be used right away, store them in air-tight, light-tight cans with a spoonful of silica gel in each. Thin-petalled, fragile, dried flowers, such as violets, usually keep satisfactorily only in the low humidity of winter-heated rooms, so careful storage of spring- and summer-gathered material of this sort is necessary. It can then be assembled safely in the autumn, and will last well until the following summer. Sturdy material does not need such care.

Leaves also hold their color best when dried in silica gel, but some can be treated to keep for years by soaking them in a glycerine and water solution (see page 11) when they take on a burnishe bronze look. This works best with suc leathery leaves as euonymus, ivy and bo Thin leaves can be pressed betwee weighted papers but before use in bou quets, they should be wafted quickl through the steam of a boiling kettle t restore a third-dimensional look. But b sure to hold them in the steam with pair of long tweezers!

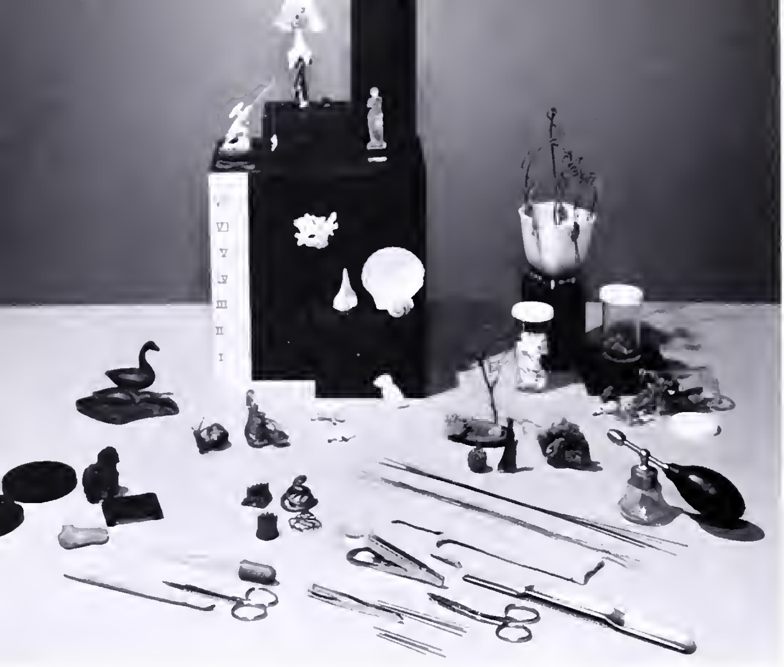
Containers

Collecting containers and accessories ca be a stimulating hobby in itself. Size i all-important, since the usual measure o a finished miniature arrangement—flowers, container and base—is not over inches. Cosmetic counters, antique an toy shops, hardware stores, seashore woods and lakes, button departments, gi shops, handcraft suppliers, museums an



Clive Webster

his miniature arrangement won a Garden Club of Toronto Gold Trillium Award. The ilver Victorian container is glued to a twenty-five cent piece because it kept wanting tip over. Plant material includes coral bells, baby's-breath, cranberry, fleabane, forget-e-not, Johnny-jump-up, pearly everlasting, periwinkle, sweet-alyssum and foliage of hickweed, parsley, fern and variegated ivy.



Accessories and tools used by autho for both dried and fresh arrangements.

galleries—all are marvelous hunting grounds. Even a black top from a vanilla bottle in the kitchen on an ordinary black button makes a handsome ebony pot for a bold arrangement of a black-painted tendril of grape, a few orange kalanchoe flowers and two or three tiny leaves of green and white variegated ivy.

More treasured are the pieces you find, usually unexpectedly, in specialty shops or on your travels; a tiny sea-blue porcelain bowl made by a famous Scandinavian potter for people who collect examples of his glazes; an antique English silver wine-taster's cup; a set of Japanese mame-bonsai containers. Soft finishes, with a little of the look of age, enhance dried flower arrangements better than something with high luster or brilliant color.

Perhaps best of all is the fun of making your own containers with modeling clay, plastic, whittled wood, or wire. And one of the most fascinating of all—ordinary preserving wax colored with bits of old crayons or candles, carved out with a simple penknife and rubbed to a porcelain finish with warm fingers. This is an especially effective pleasure for young fry, the elderly and the handicapped.

Mechanics and Tools

The simplest material to hold miniatu flowers and leaves in place in deep co tainers is dry sand. It also weights the to prevent tipping over. A good altern tive, and one useful for shallow contai ers as well, is a small piece of dry Oasi the top a little higher than the rim of th container. For very open shallow co tainers, the Oasis can be impaled on som carpet tacks fastened down with flor clay.

Dipping the end of each stem in bon fast glue before pushing it into place e sures a secure hold—and even if yo change your mind on the placing, it ca be snipped off and a new start mad Tools needed: A pair of tweezers (on with pointed ends are best); a pair manicure scissors for pruning out u wanted material; a stub-ended cutic stick to press things into place; toothpic painted brown for splints for too-sho material; glue and a can of plastic spr for fluffy seedheads. ☘

Sculptural beauty is accented in many dried and preserved items . . .

SCULPTURAL DESIGNS AND DRIED PLANT MATERIALS

Marian Aaronson

THE MODERN ARRANGER designs with emphasis on line and space and brings this decorative art close to sculpture. However, not all fresh plant materials lend themselves to being molded into new sculptural forms or to being used in a non-realistic way. For instance, the need to have the stems in water, or water-retaining substance, limits the type of placements and general decorating usage. This is one of the limitations of flowers and living plants as an art medium.

Dried plant materials, on the other hand, offer greater designing scope. They do not require moisture, and placements can be more varied and unconventional. The arranger is freer to bend, twist, or to alter the line of the plants to the desired angle. Since the material is no longer living, there may be less inhibition with manipulation, and it is much easier to experiment with less perishable items.

Dried materials provide the ideal medium for abstract design. Among the plant parts particularly suitable for the purpose are those of reeds, cat-tails, bamboo, polygonum and mare's-tail grasses. They are light and easy to dry and assemble into sculptural constructions of a permanent or semi-permanent nature. These and similar dried or preserved plants help create new patterns, which in turn can initiate new concepts of design.

Three Designs

Sculptural beauty is strongly accented in many dried and preserved items. Many seedheads have a lovely line and form which are excellent for making bold structures. Cones and husks, especially if large, help create dramatic uses. The spathe-like sheaths in Figure A, struc-

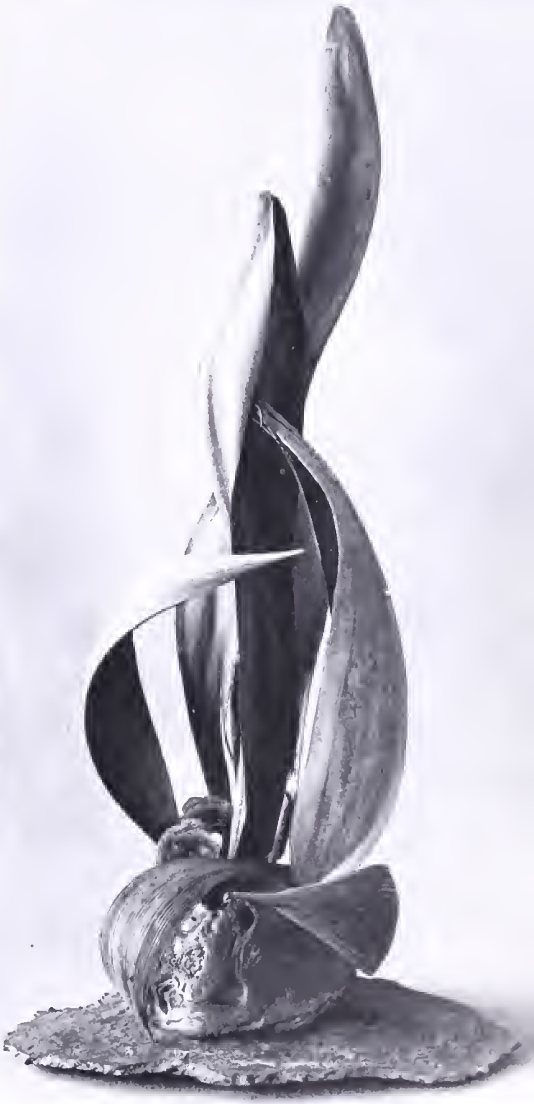


Fig. A A composition of palm spathes.

tures which in nature protect the flowers of palms, are an inspiration to the designer. Each is a beautiful piece of art and, together, they make a structure with strong sculptural meaning. The concave and convex nature of the material brings about a dynamic three-dimensional form, full of depth and movement, and one can contemplate the design from many angles, thereby gaining full appreciation of the concept. There is a pleasing contrast of color and texture which furthers the light and shade effect, providing rhythm throughout.

The spathes are complemented texturally by a pottery base of the same color. while a smooth polished stone gives necessary contrast. A structure of this sort lasts indefinitely, and the mellow, subtle hues are continually soothing to the eye. Dull, earthy colors can be as satisfying as brighter hues, especially when combined with interesting or dramatic line and form.

Figure B shows another arrangemen of strong sculptural quality. The plan material is dried agave leaves, which resemble spears. I gathered them from the hot sunny slopes of the Pyrenees where they had been dried and bleached naturally by the strong sun. They have a wonderful form, color and texture, and the drying process has exposed a fabulous, Paisley-like pattern in their structure, with colors varying from brown to beige to cream. This agave, a membe of the large plant group known a succulents, has vicious prickly spines running along the outer edges of the spears. These are very decorative but treacherous to work with, and it takes the enthusiasm and determination of a flowe arranger to win in handling them.

However, mine have more than repai the effort entailed in the collecting, an they have been used constantly in varying design forms. Here several spears o different sizes are built up into a strong compact structure. Design depth is increased by the turning of the spears i different directions, and by the space made by the lower, curled-up specimen

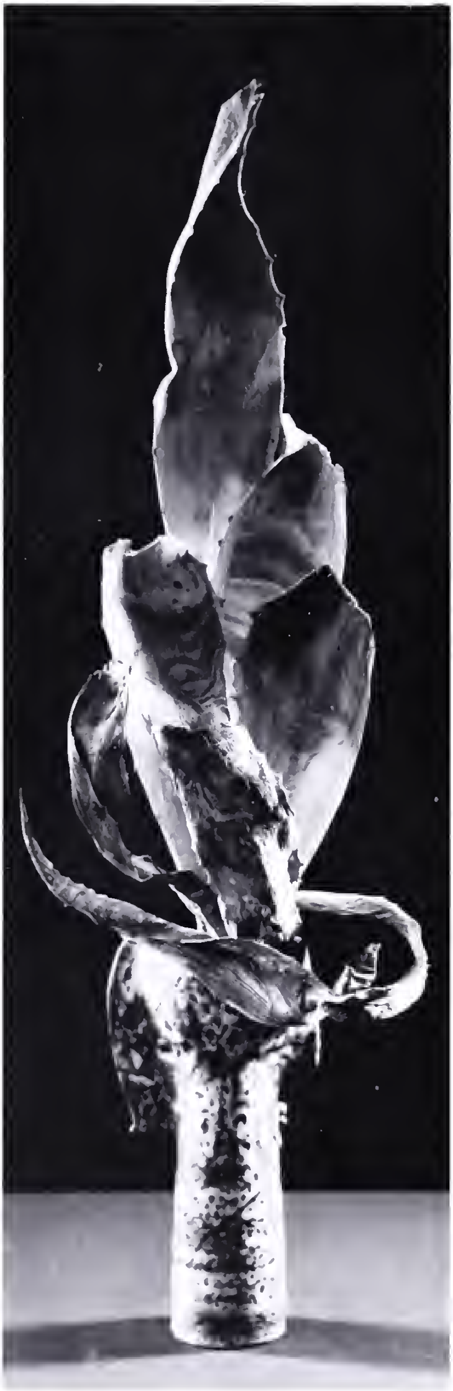


Fig. B. The sculptural quality of agave leaves which resemble spears.

The light and shade effect also strengthens the depth and movement, and it avoids a flat, static look. A blending of form and texture of container with material gives a pleasing unity and strengthens the sculptural effect.

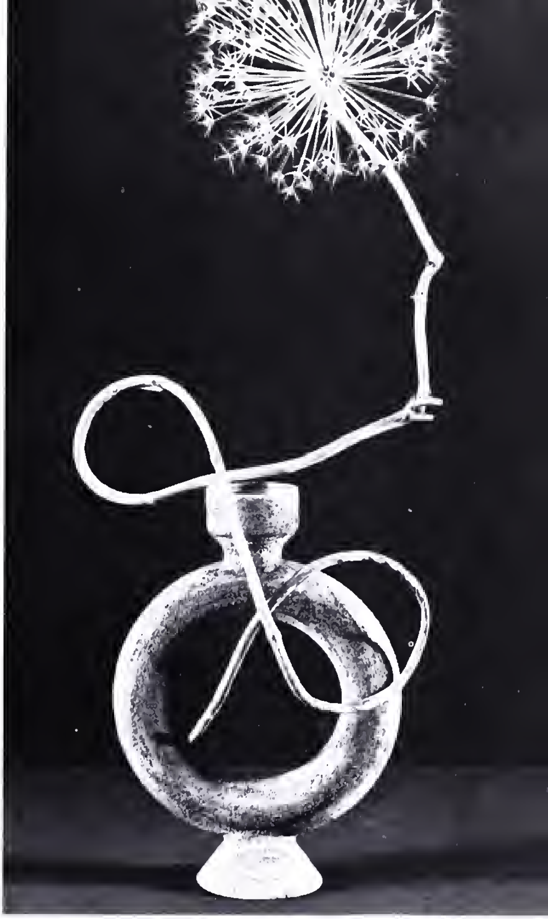
One of the attributes of a dried floral design is that each structure far outlasts the time taken in construction. This is a boon to a busy housewife, and the dried material, of course, is unaffected by room heating and a dry atmosphere. Palm sheaths, agave spears and many other similar plant parts are very tough and durable, therefore ideally suited for modern-day needs.

In Figure C the ornamental allium, an onion relative, is a little more fragile but still has the same dramatic sculptural appeal. It is used in conjunction with loops of honeysuckle vine to create an abstract design. Both echo the round sculptural form of the striking Clive Brooker pottery container. This has a rough gritty texture which the allium again repeats.

The flower arranger has a wealth of seedheads to choose from, of varying shapes, sizes and textures, many with a really exciting line and form. Plants are attractive at many stages of growth, each stage dictating a different and varied style of design. Other rough-texture seedheads for bold effects are those of lily-of-the-Nile *(Agapanthus)*, teasel *(Dipsacus)*, Scotch thistle *(Onopordon)*, sea-holly *(Eryngium)*, globe-thistle *(Echinops)*, and tall statuesque plants such as bear's-breeches *(Acanthus mollis)*, foxglove *(Digitalis)* and mullein *(Verbascum)*. An example with smoother texture is the poppy *(Papaver)*, which is very effective dried or preserved in some other fashion. Cat-tails *(Typha)* are also stately, with a more velvety texture.

Wood

Among the most exciting items of dried material one must include wood in all its varying forms. It is invaluable for spectacular sculptural effects. As a truly natural design accompaniment for flowers and leaves, it often makes an excellent foil for bright colors or adds extra interest to an ordinary grouping.



Scott Lauder

Fig. C. Abstract design with allium seedhead and loops of honeysuckle vine.

Not every piece of wood needs the complement of other plant material. Some have sufficient interest and variety in their own structure to be featured as natural sculpture, needing perhaps just the right container or base to accent their uniqueness which may be distinctive texture, subtle coloring or a dramatic line. Spectacular specimens usually look best with their line and form fully exploited. The piece in Figure D is a slice of hollow tree-trunk anchored to a base of similar wood. It undoubtedly suggests different things to different people—to some a wave, to others perhaps the en-

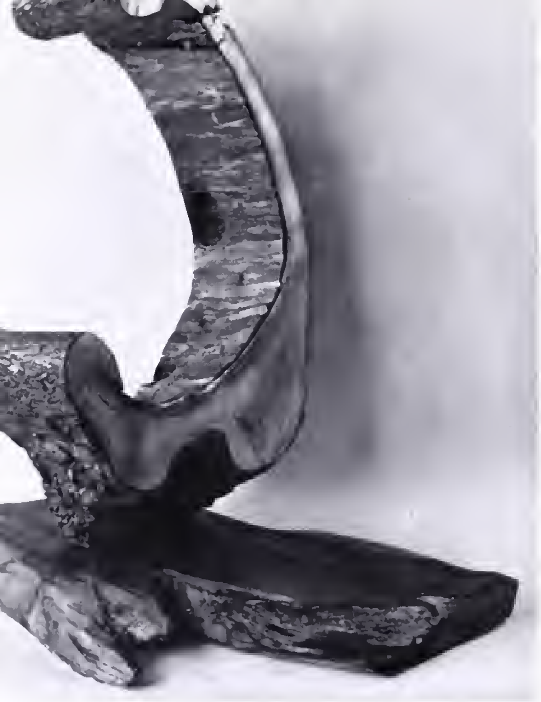


Fig. D Slice of hollow tree-trunk on wood.

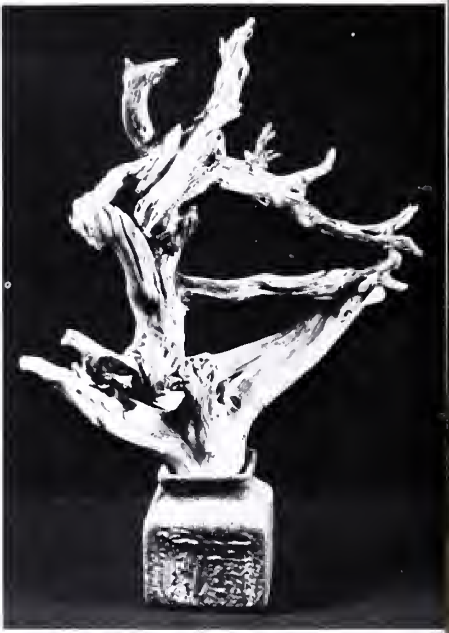


Fig. E Wood sculpture from many pieces

trance to a cave or a nook for contemplation. The wood itself has a satisfying variety of smooth and rough textures to give an illusion of extra depth. The variation of different tints and tones of brown adds further interest. It is, in fact, a difficult piece to combine successfully with other items, which proves it is complete in itself.

Figure E shows a wood sculpture built up from several separate pieces. One uses the same principles of balance, proportion, rhythm and contrast as in a flower arrangement. All the pieces used have the same lovely silvery-gray color and a weathered texture—the action of sun and wind. One piece was built on top of the other to give a pattern of solids and spaces. The heaviest piece is at the base, but the widest part of this is well above the mouth of the container, to give the sculpture greater buoyancy. Each section is well silhouetted so that its individual attributes can be enjoyed fully. The container blends in color and texture, and its strong, square line provides balance without reducing the rhythm of the design or making the sculpture appear too firmly held to the ground. It is striking against a black wall.

There are many more types of wood that lend themselves to interesting designs. One of the most desirable is the tree ivy *(Hedera helix arborescens)*, which twists and bends in the most weird and wonderful way. When the bark is stripped off the milky-white wood underneath is dramatic. Again, several pieces can be combined to make a complete design structure. The starkness of the wood can be softened with a wood dye or boo polish if a softer effect is preferred Painted black, it can be very powerful Honeysuckle, wisteria, other vines, and willow shoots may be easily coaxed into new shapes. They can be soaked in water to soften the wood, after which the shape are tied until the wood has hardened and dried. The new patterns will then remain fixed. It is better still to pick the branche when they are fresh, and tie them into the required curve or angle until the effect satisfies. ❧

Dried materials ready for arrangement at Colonial Williamsburg.

Dried arrangement (right) by Lois Wilson. Candlestick design (below) by George W. Smith.

Joan Dutton arrangement at Colonial Williamsburg (above); design by Lois Wilson (left); glass dome (below) by Betty Peebles.

Wall plaque by Shirley Brooker (left), wreath by Barbara Laking (below).

Color photos by Frank J. Davis
(Colonial Williamsburg Foundati
Jim Fish, Warren Jepson & Co.,
and Clive Webster.

Contriving new forms . . .

CREATIVITY AND THE CONTRIVED DRIEDS

Esther Veramae Hame'l

CREATIVITY is not some special virtue given to a favored few by a discriminatory fairy godmother. The imagination essential to art is as universal as memory, and the creative nature is to some extent present in all of us. It is the ability to bring something new into existence through the reshaping, juxtaposing and combining of familiar elements. What is creative is not the eccentric or bizarre but the unusual, ingenious or unprecedented.

Contriving new forms, then, comes under the title of creativity. Contriving plant forms from common plant parts is a fairly recent way of working with horticultural materials. Fragmenting plants and reassembling the parts in a different manner extends the possibilities of design and enriches our perception of plants.

To encourage arrangers to see and create unique plant forms other than as nature made them does not discredit our horticultural medium. Much satisfaction can be derived from fashioning novel shapes from materials that have been collected, dried or treated with glycerine. When familiar objects are placed in a different context, they take on the patina of newness or "difference," and this heightens the interest of both the doer and the viewer.

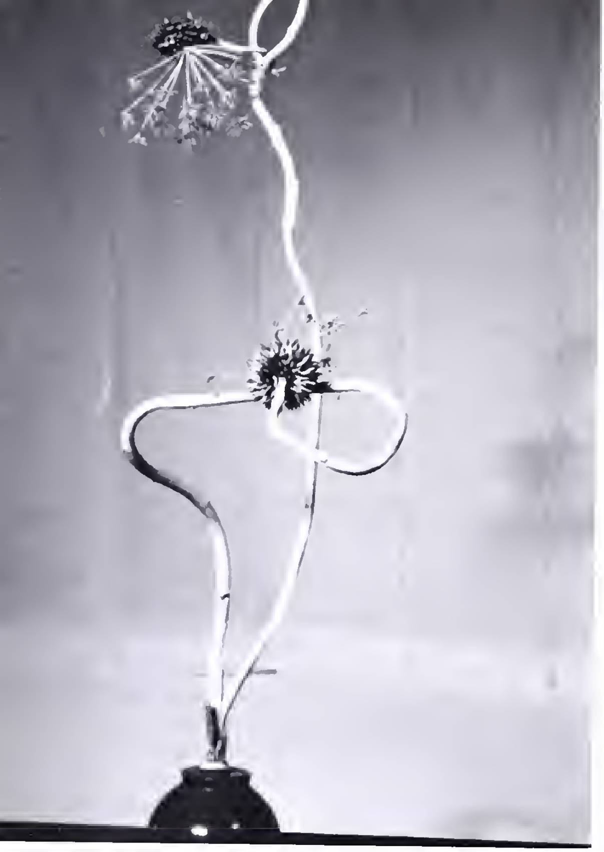
Contrived flower forms, a phrase originated by this author, are not only for the expert arranger, they allow everyone who loves working with small objects to use plants in a unique, creative way. It should be mentioned here that turning, twisting, bending or otherwise distorting the natural shape of plant materials, while often exciting to use and to see, should not be confused with contrived forms. Actually such material is merely manipulated rather than restructured.

Contrived flowers and leaves are ones constructed from previously unprocessed real plant parts that can be preserved by any of the various methods described elsewhere in this Handbook. They should not be confused with artificial flowers or foliage. The artificial category includes hemp, rope, wood fiber, and other processed plant products, in addition to plastic, glass, silk, or metal flowers, as well as shells, feathers, rocks, and other natural but *not* horticultural materials. No artificial flowers or leaves such as these are allowed in the flower shows sponsored by the National Council of State Garden Clubs, since the purpose of the shows is to educate the public about the versatility of horticulture.

It's easy and fun to contrive flowers once you begin to realize that the natural shape is not sacred. A generous and prophetic Mother Nature seems to have anticipated the possibility that we would want to fragment her flora because she made so many segments of plants complete units in themselves. For example, take apart a deodar cedar cone. Strip all the top "petals" (actually scales), leaving only the bottom row or two; let the large center core remain as a unique enlarged "stamen." Then glue the removed "petals" to centers made from slicing a corncob into rounds, mount on wire, and tape with floral tape. Glue some transluscent discs from honesty *(Lunaria)* to the lower scales of another small cone or to a teasel pod, leaving the top to form a daisy-like center.

To contrive flowers means to fragment, prune, reshape and regroup plant parts. Experiment with various combinations.

(Continued)



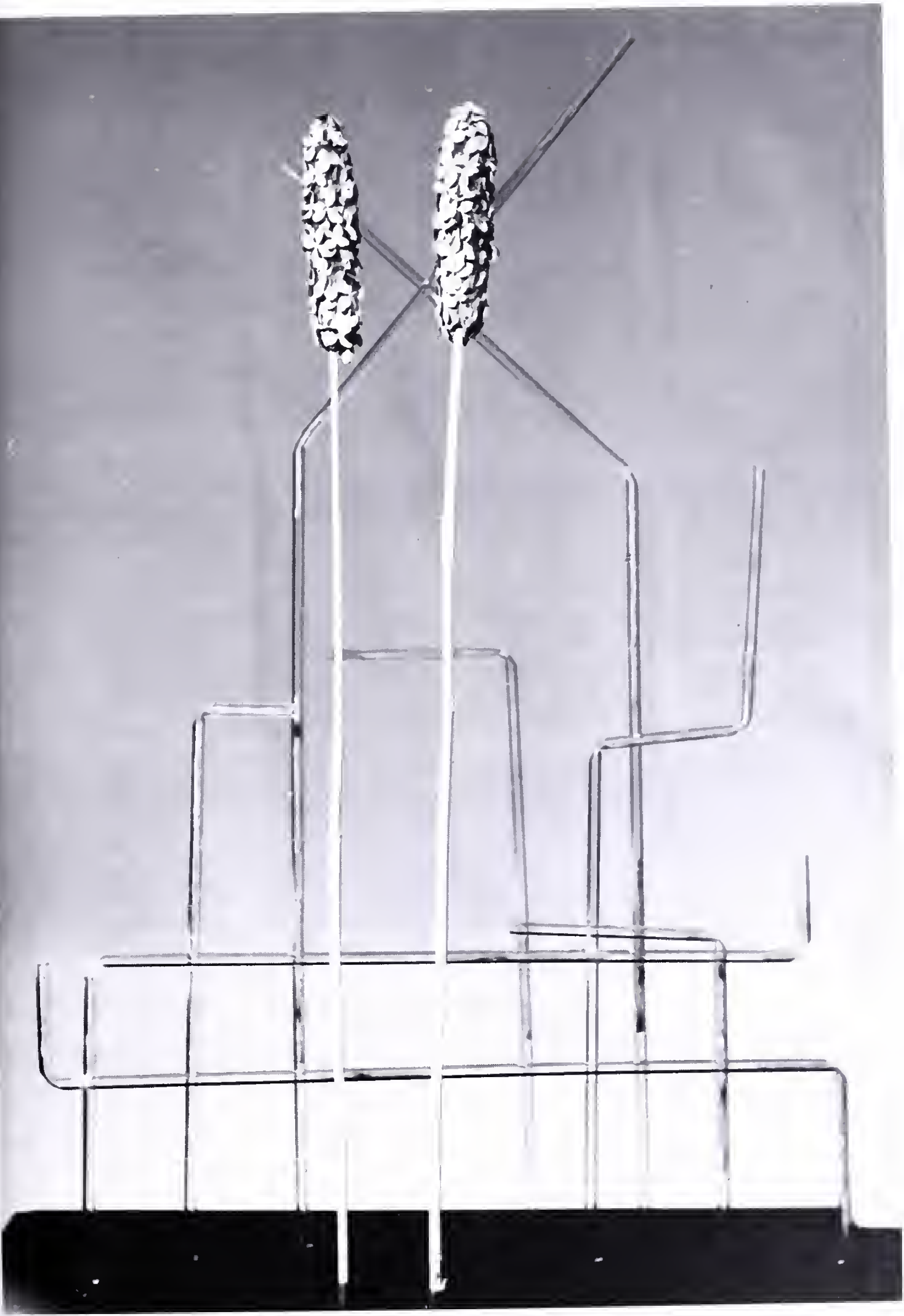
Gemini Here in defiance of the old rule of three, twin heads of wild spray-distorted Canadian thistle take flight with two umbels of water-hemlock glued to their centers. Before mounting, the water-hemlock heads were crystalized by dipping in melted alum.

As nature gives them to us, the rigid lines of some plants such as cat-tails *(Typha)* and goatsbeard *(Aruncus)* may limit their design use. Try removing such seed heads and reassembling them on the twisted stems of another kind of plant to create a new design form. Such "contriveds" would be well within the realm of recognizable plant material, but one which may more aptly fit your wish to consider plant material as pure form rather than as a specific type.

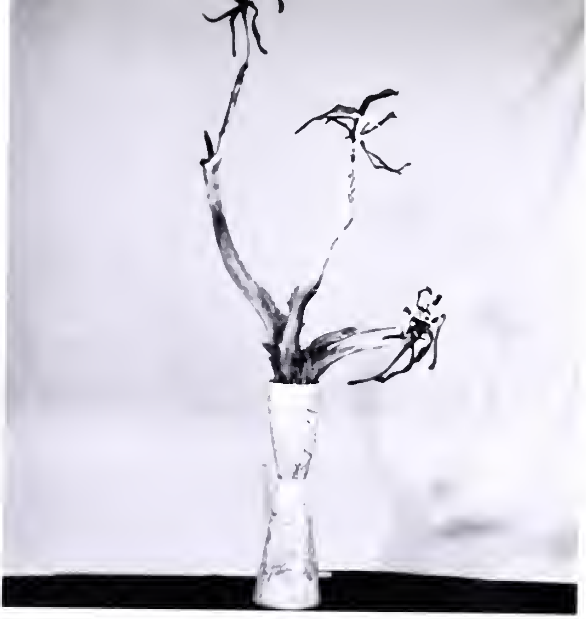
Contrived flowers can be constructed from any plant material, regardless of how it is preserved. Creative plant "doctors" use petals that have been dried in silica gel, leaves that have been treated in glycerine (or even anti-freeze), as well as those that were air-dried or left to dry by nature.

Petals are, of course, the most appealing parts of most flowers, but they are also the most fragile, especially when dried. Thus it is usually best to construct the floral petal form you envision before placing it in a granular drying medium such as silica gel. One popular form is the "glamellia." Start with a fresh gladiolus bud, then cluster florets around the bud, and wire securely before placing the whole in a granular mix for the drying period. The result will resemble a beautiful double-flowered camellia. Make a similar rose-like form by using the glycerine-treated leaves of violets, geraniums or galax. Handle in the same manner and dry in granular mix.

Don't restrict your contriving to petals. Citrus fruit peels can be cut to shape, wired, and dried in the oven at 100 degrees F for 4 to 5 hours. Then simply assemble and tape them in a way that pleases you. One of the most popular contrived flowers I use consists of peels of three or four bananas! Lay the split banana skins on cement in the hot sun



Architectural Angles Stately cat-tails, studded with hydrangea petals sprayed shocking pink, are combined with angled plastic rods threaded with random lengths of hot-pink wool yarn. The taut lines and textured masses shape space into geometric patterns which seem architecturally derived, simulating skyscrapers.



Sun-blackened banana peels are wired, taped and assembled as one would a corsage, using corn husk for center contrast. An eye for natural design was used to select a three-armed black and gray piece of wood that complemented the color of the contrived flowers. Small holes were drilled into the wood ends into which the flower's wire stems were thrust.

Photographs by A. Mulkey

after pushing a wire into the stem ends. (Don't wait to wire when the ends are dry because they will be like rocks.) Leave the skins until they turn black. Place three or four dried skins, one on top of the next; glue a pod or cluster of corn husk in the center, then wire and tape to get an exotic black form similar to an orchid-flowering dahlia. The skins can also be sprayed with paint.

Corn husks are very congenial when it comes to contriving forms. Soak the dry husks in hot water five minutes. Wrap them in damp towels to keep them moist and pliable while you work. Press with a warm iron if a smooth texture is desired. Husks are often used to simulate roses, but the true innovator copies the petals of sweet peas, lilies, daffodils and orchids for the same purpose. A husk accepts spray paint beautifully and performs for many seasons in its new flora role. Pods, nuts, cones, seeds, roots, fungi and lichens can be recruited for a new role in a contrived form. For popcorn cat-tails, thread one or two dozen large popped kernels on heavy wire. Top with a toothpick, tape and spray brown. Try contriving flowers from the seed heads of wheat, too. Make daisy-like blooms by inserting yellow bearded wheat seed heads around the diameter of a one-inch styrofoam ball. Do this after the balls have been spread with glue, rolled in wheat kernels and sprayed brown or another hue.

In the arranger's rush to use more spectacular flowers, common vegetables and fruits are often overlooked. Pieces of broccoli dry to an unusual green in silica gel, and when bunched and wired together form a highly textured flower form. Also, bear in mind that contrived foliage can be made from cornhusks and from dried leaves of aspidistra or magnolia that have been treated with glycerine and cut into smaller leaf shapes. Tape or glue the new "leaves" to branches or heavy wires.

The "delighting" ability of horticulture is heightened when common things are presented in a less-than-common way. We have all seen hundreds of pine cones and strawflowers. One more draws no comment and awakens no challenge, but when that cone is mounted on a contorted willow branch, or combined with the discs of the money plant *(Lunaria)*, or sliced to resemble a rose, or covered with dried grass heads glued between the scales, a new form is created and there is the realization that creativity has been released. ⁂

Pressing flowers and foliage for

FLOWER PICTURES AND STATIONERY

Leonora Spicer

PRESERVING FLOWERS and foliage for this purpose is an art which requires time, patience and a "seeing eye" for plants with good design possibilities.

Collecting

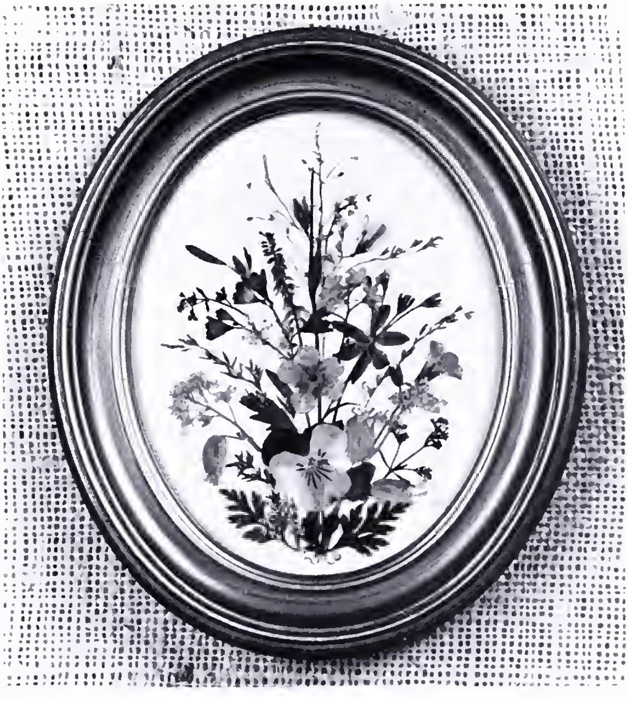
Cut flowers and foliage when dry. Around noon on a sunny day is usually a good time. Select the choicest specimens, just before they have reached maturity, but be sure to include some flowers and foliage in different stages of development. The arranger discovers by trial and error the flowers that best retain their form, color and texture, but one can save disappointment by avoiding fleshy- or thick-stemmed flowers, for example, lilies, petunias and poppies, because they do not press or dry well.

Here are three essential points to remember: The faster the flowers and foliage are dried the better their color will be; press as soon as possible after collecting; finally, never press wilted materials.

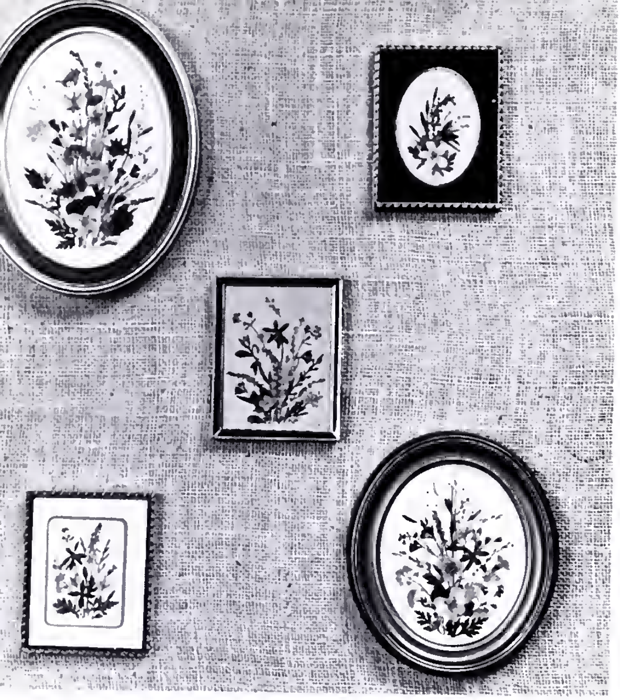
Pressing

Spread Kleenex or similar absorbent tissue on newspaper. Arrange the plant material in pleasing shapes on the tissue. Place some flowers flat and some sideways. Shape some stems in graceful curves for line interest in designs. Prune off unnecessary foliage and avoid overlapping of flowers and foliage where possible. Cover plant material with

James C. Fish



The process for achieving this flower picture began first with the gathering of suitable plant material, then with pressing between layers of Kleenex for several weeks.



Flower pictures are enhanced by selecting the approriate kind, shape and size of frame as well as mat and background.

Kleenex, then newspaper. Place sheets between the pages of an old telephone directory, which has non-shiny paper—an aid in the immediate drying process. Repeat this until the directory is reasonably full. Allow several pages between each lot of sheets. Place a board under the directory and one on top. Cover with heavy weights.

Change damp papers for dry ones every day for three days. Dampness will turn white flowers brown, and mildew will ruin the materials. Do not disturb for several weeks. The length of time for drying will depend on the thickness of the materials and on atmospheric conditions.

After pressing, material should be stored in folders or between sheets of shiny paper, which does not absorb moisture from the air. Place name tags or paper slips between the pages—write the name of the plant that is between each page. To locate the materials quickly, it helps to use various colored felt pens for different colors—yellow for buttercups, blue for lobelia. *Important:* Do not make up flower pictures in humid weather.

Pictures with Pressed Flowers

There are a great variety of frames and backgrounds available today. Select a frame, and make sure that the glass is clean on both sides. Decide on a background that is suitable in color and texture, and cut it to fit the frame.

For beginners, cut out a second background and arrange the plant material on it, before placing the design on the permanent background. Create an interesting line to your design. Watch proportion and scale. Reduce bulk by cutting away overlapping stems, but overlap some petals and leaves to create depth. Place some flowers in profile and some full face. Graduate the size of the plant materials used, keeping the largest flowers and those with advancing hues near the center of interest in the design.

Next, using a small amount of Elmer's or similar-type glue on a toothpick, carefully secure the flowers, stems and foliage to the background. Lift the pressed material with tweezers, and put the glue carefully on the underside with the toothpick. If there is any excess glue, remove it with absorbent tissue. When the glue is dry, place the glass in position. Fit the frame, turn the picture over. Tack the frame in place. Finally, add a hanging device. Also, bear in mind that fading may occur should the dried flower pictures be exposed to bright sunlight, so keep them in indirect light if at all possible.

Notepaper with Pressed Flowers

Small flowers and foliage are pressed for notepaper designs. Follow these practices: Create simple, uncluttered designs with good lines; glue all materials to good quality paper. To protect the design, cover it with Mactac or other similar adhesive clear plastic material. If using embossed paper, cover only the sunken area with plastic.

Here is a selection of plant materials for flower pictures, stationery, place mats, lampshades and divider screens.

Flowers

Aster	*(Aster spp.)*
Basket-of-gold	*(Alyssum saxatile* 'Compactum')
Bellflower, Dalmatian	*(Campanula portenschlagiana)*
Buttercup, Double-flowered	*(Ranunculus repens* 'Pleniflorus')
Campion, Bladder	*(Silene cucubalus)*
Clover, White Sweet	*(Melilotus alba)*
Coral Bells	*(Heuchera sanguinea)*
Cosmos	*(Cosmos bipinnatus)*
Forget-me-not	*(Myosotis scorpioides)*
Globe-flower	*(Trollius europaeus)*
Herb Robert	*(Geranium robertianum)*
Johnny-jump-up	*(Viola tricolor)*
Lobelia (annual)	*(Lobelia erinus)*
Pansy	*(Viola tricolor hortensis)*
Queen Anne's-lace	*(Daucus carota)*
Scilla	*(Scilla sibirica)*
Speedwell (pink)	*(Veronica 'Minuet')*
Speedwell, Woolly	*(Veronica incana)*
Trefoil, Bird's-foot	*(Lotus corniculatus)*

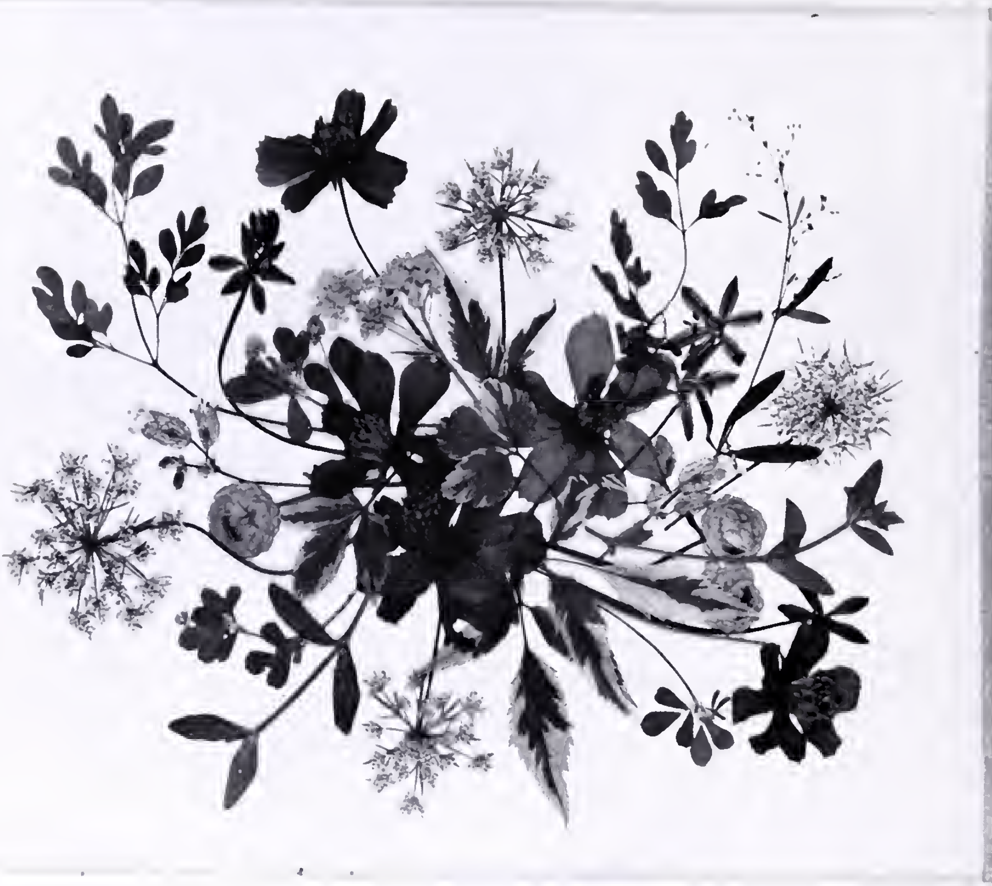
Leaves

Bedstraw	*(Galium spp.)*
Blackberry	*(Rubus spp.)*
Clematis	*(Clematis)*
Dusty Miller	*(Centaurea cineraria)*
Goutweed	*(Aegopodium podograria* 'Variegatum')
Honeysuckle, Climbing	*(Lonicera spp.)*
Medic, Black	*(Medicago lupulina)*
Raspberry	*(Rubus spp.)*
Vetch	*(Vicia sativa)*

Ferns

Bracken	*(Pteridium aquilinum)*
Common Polypody	*(Polypodium vulgare)*
Lady Fern	*(Athyrium filix-femina)*
Maiden-hair Fern	*(Adiantum pedatum)*
Narrow Beech Fern	*(Dryopteris phegopteris)*
Royal Fern	*(Osmunda regalis)*

Pressed flower designs for notepaper should be simple and uncluttered. The flowers are glued in place and then protected with a clear plastic material such as Mactac.



James C. Fish

TABLE MATS

For a distinctive table setting, you can indulge your love of flowers by using pressed flowers for table mats. Choose a background to blend with or complement your dining-room color scheme. Table mats and centerpiece should be keyed to each other.

Select pressed flowers and arrange your designs. Flowers are held in place by using a very small amount of glue. Rayon Filament Tape No. 880 may be used for binding. Measure the circumference of mat, allowing an inch of tape to overlap. Miter corners front and back.

Four materials are required: heat-resistant glass, background material, cardboard and cork or felt.—*Marian Bricker*

Movement and the illusion of movement

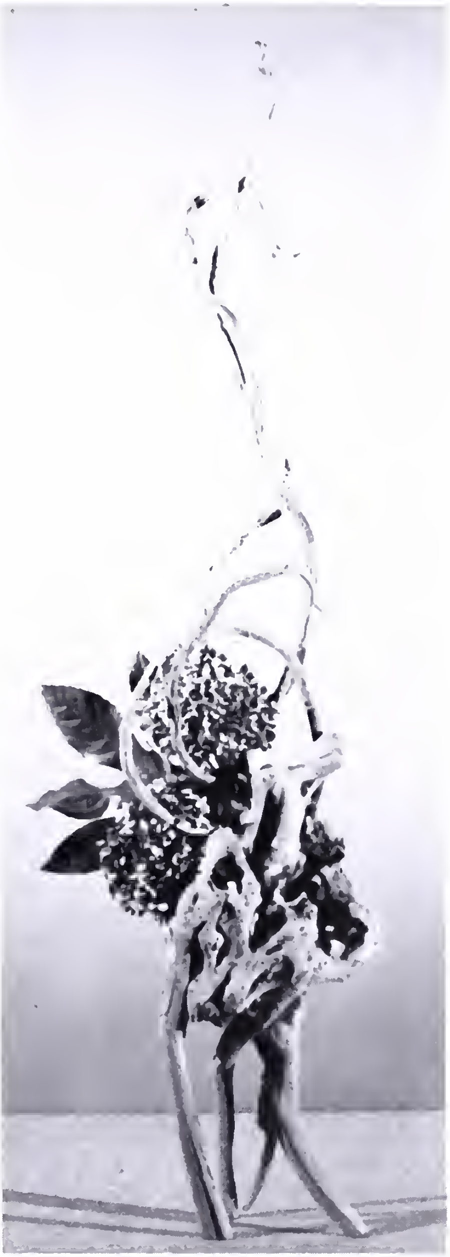
MOBILES, STABILES AND STAMOBILES

Frances Louise Bode

KINETICS, the study of motion, is a term borrowed from science that has inspired a major movement in 20th-century art. As early as pre-World War I an artists' group, the Futurists, became interested in the impact of speed and motion upon art and artistic endeavor. The first application was in certain paintings depicting multiple, overlapped images that gave the impression of movement. Perhaps the most famous instance was Marcel Duchamp's "Nude Descending the Staircase," which created a furor in the art world when it was unveiled. This was an example of illusionary kinetics, for the motion was suggested by the artist but required the active participation of the viewer to respond to the visual symbols, forms and colors.

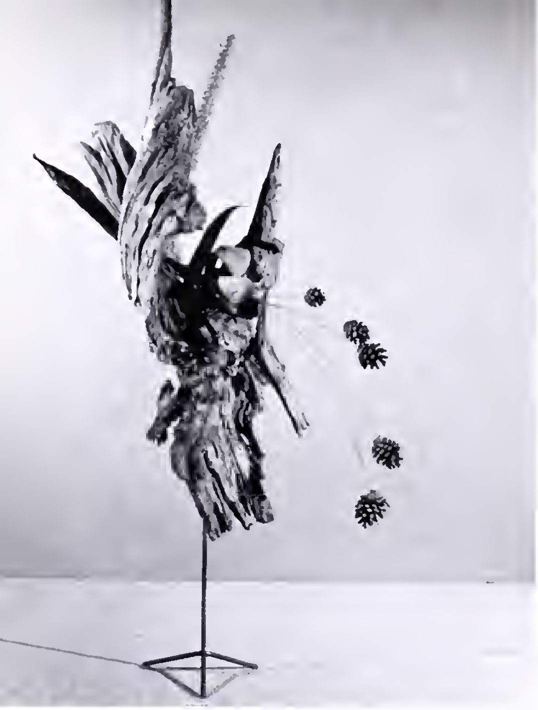
In America Alexander Calder was the first to experiment with illusionary movement in his wire sculpture of animals and circus figures. Later he turned to non-representational shapes in his sculpture but he retained the feeling of arrested or impending motion. These were given the name stabiles, a ground-oriented sculpture with the impact of a moment frozen in time and space. This was sculpture that could not be contained by space but rather became a part of it.

The stabile is eminently suited to flower arrangement since the materials with which we work can be so readily adapted to the development of a sculptural form



Designs by author, photographs by W. T. Bode

Stabile Limbs emerging from a silver-gray weathered wood burl were cut to create the legs of this stabile. Striking threads of gray kelp, found at the seashore, were attached with wood screws, the heads countersunk and filled with gray-tinted wood dough. A piece of styrofoam, painted gray, was wedged into a crevice of the structure to hold glycerine-treated hydrangea flower heads and the aralia leaf.



Stamobile The structure of this stamobile is a piece of wood from the High Sierra. Dried ti leaves create a diagonal movement repeated by the floating pine cones on piano wire which move in every air current.

with illusionary movement. Although the arrangement itself cannot move we must create strong linear patterns and structural rhythms that impel the viewer to move, to feel the need to walk around the structure to fully enjoy it. This implies, of course, that the arrangement must be free standing and truly three-dimensional, which differentiates it from an arrangement against a wall that simply has rhythmic lines within it.

The stabile in flower arrangement may be designed in a vase or as a free standing structure that has concealed sources to support the plant material. It also can be elevated on a rod or stand to become an airborne sculpture. To be a flower arrangement it must incorporate some plant material, fresh or dried or a combination of the two, even if the structural members are actually of plant origin, as weathered or drift wood, etc. Dry materials may be secured in styrofoam spray painted to match the structure or in concealed pin holders. There are a number of ways the fresh plant materials can be used without diminishing the design impact of your stabile. Soaked Oasis wrapped in aluminum or florist's foil can be wedged inconspicuously into an opening or recess. Small cans (tuna, mushroom, etc.) or little jars painted to blend with the structure can be filled with either Oasis or small needlepoint holders. Cans can be nailed or screwed to the structures and be made a part of the overall design.

The stamobile, a word coined by Esther Hame'l in her book, *The Encyclopedia of Exhibiting and Judging,* was the next logical step in the development of kinetic art. To a structure with illusionary movement was added the excitement of actual movement, mobile units. These moving parts gave to the implied movement of the supporting stabile the changing patterns of forms moving through space in varying new relationships. The action of air currents affected the speed and amount of motion, and the different positions, in turn, determined the design relationships of the mobile forms to the structure. Mechanical movement can also be used (for example, turn-tables or electric- or battery-operated motors) which induce a more calculated motion than such natural sources as heat or air currents.

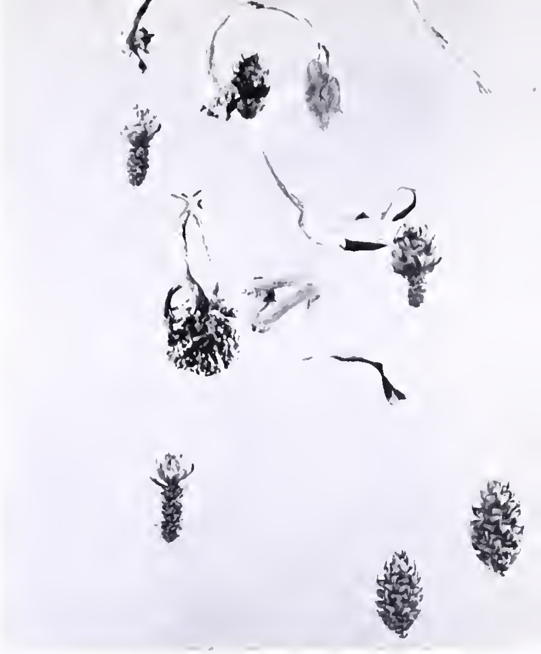
There are several ways to introduce movement with mobile parts. You might use a vertical spring or piano wire for an up-and-down movement, or try to suspend an object on a length of nylon monofilament (fishing line) for a pendulum or twirling effect. More elaborate relationships can be achieved by using horizontal members suspended on monofilament to which other items or whole units can be attached. Each design will dictate the kind and amount of mobility that is suitable. Always keep in mind that if what you add does not contribute effectively to the idea you are trying to develop, abandon it. It is perhaps the oldest adage in flower arrangement but is still worthy of mention—when in doubt, leave it out!

A most dramatic development in the concept of space in design is the addition of a time-and-motion dimension. When moon missions and satellites, with their count-downs and lift-offs, have put the concept of time-and-motion very much in our consciousness, it is interesting to note that as early as the 1930's Calder was translating them into an art form when they were only science-fiction fantasies. Long interested in the movement of men and animals, he at that time exhibited his first abstract mobiles employing non-representational shapes in either motor- or air-propelled organizations in space. Their charm was in the ever changing relationships as the individual parts moved independently but in carefully controlled design patterns.

Today mobile is a household word. You can buy wind chimes of bamboo, ceramic or shells that move and make sounds on the patio or porch. There are cardboard, plastic and wood mobiles to hang over the baby's crib or to decorate the family room. All of these mass-produced types attest to the popularity of the mobile but they cannot give you the artistic and creative satisfaction that making your own will. If you use the "one-of-a-kind" objects from nature there are infinite possibilities for design organization.

Mobiles have certain mechanical problems that must first be surmounted. The weight, size and shape of each part is of special importance. To achieve the design that is wanted, first lay out on the table or floor the various parts in the relationships that you would like to have them appear. The articulation (movement) of each part alone and in reference to all other parts must be determined. As an aid for this, I suggest you turn to Anne and Christopher Moorey's *Making Mobiles* (Watson-Guptill Publications, New York, 1966) or Harry Zarchy's *Mobiles* (World Publishing Co., N.Y., 1966).

To begin the actual construction, it is most successful if you start with the lowest organization, balance this, then move upward to the next unit. As each grouping is stabilized and is related to the whole you can see the form and line relationships develop. Swivels that fishermen use on their lines are useful to facilitate movement, particularly for mobiles that are dependent upon air currents. These are available in many sizes and it is best to select the smallest possible one for the materials you are using so they will not become a design factor.



Mobile "Where the mountain meets the sea," a mobile of dried kelp and red-fir cones, some nibbled into tree forms by chipmunks. A beige jacaranda pod contrasts with the gray and red-brown materials.

Nylon monofilament is the most invisible material for joining individual members and various units into the completed mobile. This fishing line is available in many thicknesses, measured by the weight it will support. Use the lightest possible for each segment to keep it as inconspicuous as you can, because one of the charms of the mobile is the illusion of objects floating freely in space. As you work, remember that the most dramatic effects in a mobile are achieved by the very "near misses" and the space-form relationships as it moves. ❧

Beauty plus better preservation

DRIED FLOWERS UNDER GLASS DOMES

Betty Peebles

THERE is a certain sentimental aspect to designs of dried plant materials under glass domes. In Victorian days, flowers made from wax, shells, wool and beads were protected in such enclosures. Today we, too, get tremendous pleasure from preserved flowers and foliage under glass. The domes exclude humidity and make it possible for us to enjoy even the most fragile material throughout the year, even during the most muggy weather.

The glass dome used in the illustration is 11 inches high and 5½ inches in diameter. The teakwood Chinese base is 5½ inches in diameter.

All plant material used in the design was dried in silica gel. Natural stems were left intact, and no wiring was done prior to drying. Green florist's tape was used to apply the No. 26 wire to the stems of the dried plant material. The mechanics for design consisted of a small piece of green Oasis 3 inches in diameter and 1½ inches thick. The Oasis was attached to the base with Oasis glue.

The materials for the top of the design were put in place first, care being taken that the buds did not touch the top of the dome. When all the tallest materials were in position, the middle and lower areas of the design were carefully completed. It is necessary to test the width of the design several times by placing the dome in position.

In order to create an illusion of depth, blues of the delphinium and leaves of various plants were employed. Smaller materials, among them rose buds and honeysuckle, were placed on the outer perimeter of the design, creating a light airy appearance. The "heavier" materials, such as the fully developed roses, May-apple and leopard's bane were used as areas of interest.

Materials Suitable for Designs Under Glass Domes

Bridal Wreath	*(Spiraea prunifolia)*
*Clematis, Sweet Autumn	*(Clematis maximowicziana;* synonym: *C. paniculata* of North American gardens)
Coral Bell	*(Heuchera sanguinea)*
Delphinium	*(Delphinium spp.)*
*Fleabane	*(Erigeron spp.)*
*Forget-me-not	*(Myosotis scorpioides)*
*Honeysuckle	*(Lonicera spp.)*
Jacob's Ladder	*(Polemonium caeruleum)*
Leopard's Bane	*(Doronicum caucasicum* 'Madam Mason')
May-apple	*(Podophyllum peltatum)*
Mock-orange	*(Philadelphus spp.)*
Queen Anne's-lace	*(Daucus carota)*
Rhododendron	*(Rhododendron spp.)*
Roses	*(Rosa spp.)*
*Salvia, Blue	*(Salvia farinacea* 'Blue Bedder')

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* Foliage, not flowers, used.

George Taloumis

Delphinium blooms are a good source of blue for dried designs placed under glass domes.

Domes exclude humidity, extending the longevity of dried materials used in arrangements.

Design a wall hanging with air-dried materials

WALL HANGINGS

Doreen Henry

DECORATIVE wall hangings of dried materials can be made in a variety of sizes and on backgrounds of burlap, velvet, polished wood panels or any type of background that suits the purpose. The length should be in pleasing proportion to the width, and the materials selected for the design should be in scale with one another and with the background.

Best results are obtained by using plant materials that have been air-dried. They are usually less fragile than flowers preserved in silica gel and will retain their fresh appearance indefinitely, as will glycerine-treated foliage. In selecting material for designs, look for interesting lines and forms, contrasts of textures, and compatible colors. A pleasing and harmonious design on a wall hanging is achieved as in a flower arrangement by the application of the principles of design. Visual balance, a rhythmic flow of material, good use of scale and proportion, a dominance of a particular color, line, form or texture, as well as some contrast to emphasize differences and to add a little more vitality, will produce the desired result. Good design in a traditional radial pattern usually requires that light colors and small flowers be used at the top and sides of the design. Gradually work in the brighter colors and larger flowers near the focal area.

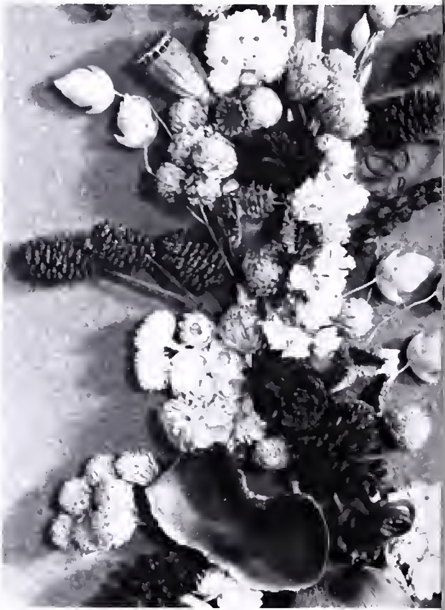
Plant materials can be fastened to the background with a white glue that dries to a clear finish. A shallow dish or jar lid is an ideal container for holding small portions of glue. A pair of tweezers is a handy tool for dipping small pieces into the glue and maneuvering them into place.

For beginners the following steps are useful.

1. Prepare background material.
2. Arrange plant material on background. Do not glue.
3. Make a sketch of the design.
4. Remove material and glue to back ground, use sketch as a guide *or* transfer design piece by piece to a secon identical background.

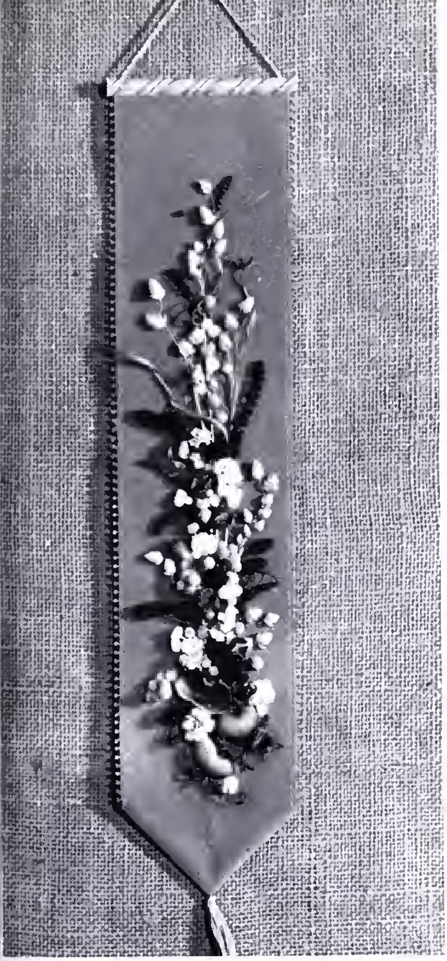
For those experienced in working ou designs, a glue-as-you-go procedure ca be used.

Since the line material usually dictate the design, it is glued in place first. Th smallest flowers, berries, or pods ar placed near the top of the design, following close to the line material. Filler i added next to provide more interest i color, texture and form. The focal are is usually found in the widest area an near the base of the design. A gradua tapering off of material at the base prevents a chopped-off appearance.



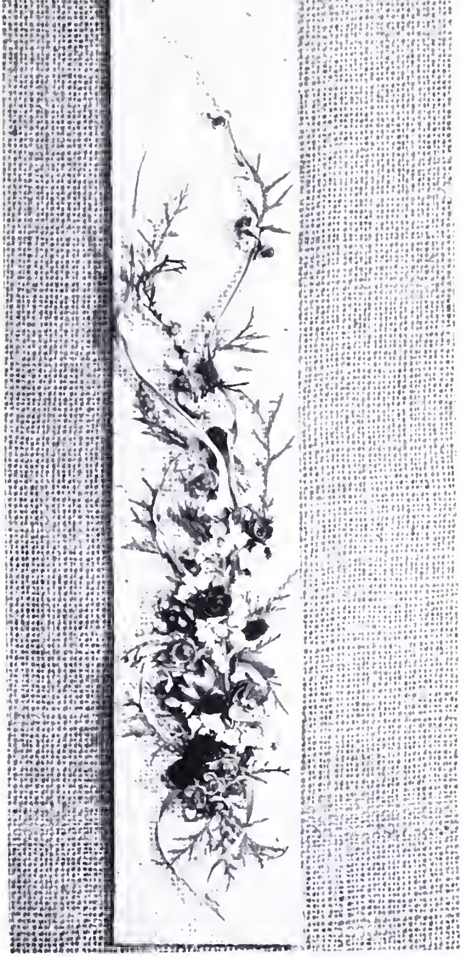
Photographs by James C. Fis

Close-up of wall decoration on gold ribbo shown on opposite page (left).



A piece of gold velvet ribbon 8 inches long and 4 inches wide served as background. A narrow strip of ¼-inch wood molding was glued across the top raw edge and over the ends of a gold silk cord which serves as a hanger. A gold tassel attached to one inch of cord was glued in the center-back of the lower edge. The lower corners were folded and glued to the center-back. This produced a V-shaped finish to the ribbon. Plant materials used:

Alder (fruits)	*(Alnus spp.)*
Beech (nut husks)	*(Fagus grandifolia)*
Coconut (perianth)	*(Cocos nucifera)*
Grape (tendrils)	*(Vitis spp.)*
Lonas	*(Lonas inodora)*
Pearly Everlasting	*(Anaphalis margaritacea)*
Poppy (seed capsules)	*(Papaver spp.)*
Quaking Grass	*(Briza minor)*
Sea-lavender	*(Limonium latifolium)*
Sensitive Fern	*(Onoclea sensibilis)*



A beige burlap strip serves as a background. It was cut 30 inches long and came in a roll 2¾ inches wide with finished edges. The burlap was folded in half and glued down by bringing the ends to the center-back. A small canvas hanger was glued to the back, an inch from the top. Placing the burlap under a heavy object or several books while the glue dries assures a firm flat surface on which to work. Plant materials used in the design include:

Alder (fruits or "cones")	*(Alnus spp.)*
Arbor-vitae	*(Thuja occidentalis)*
Bittersweet	*(Celastrus scandens)*
Columbine (seed pods)	*(Aquilegia x hybrida)*
Hemlock (cones)	*(Tsuga canadensis)*
Poppy (seed capsules)	*(Papaver spp.)*
Sedge	*(Carex spp.)*
Spruce ("rosettes" from cones)	*(Picea glauca)*
Starflower	*(Syngonanthus elegans)*
Statice (annual)	*(Limonium sinuatum)*
Strawflower	*(Helichrysum bracteatum)*

PLAQUES

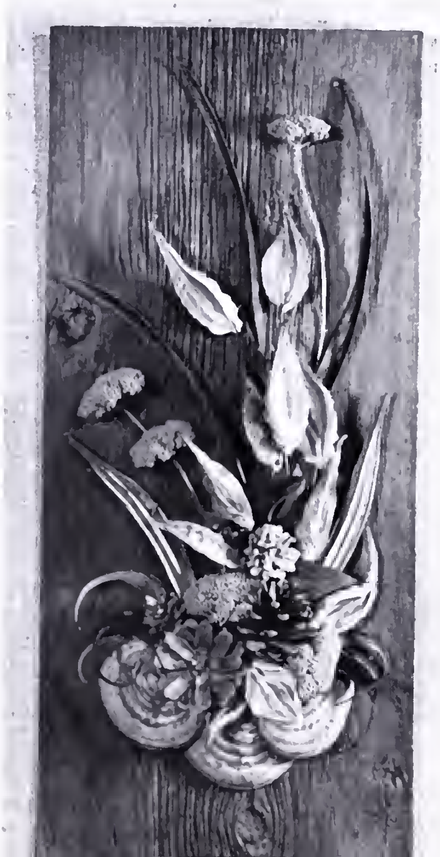
Shirley Brooker

Plaques made of preserved plant materials are very popular for home decorations and for flower show classes. Preserved materials are glued to a compatible background. An area of interest in a radial pattern is developed at or near the single point of emergence.

Plaque on Barn Board Plastic barn board is very light and easy to work with. Materials used:

Bracket Fungus	
Catalpa pods (split)	*(Catalpa speciosa)*
Milkweed pods	*(Asclepias syriaca)*
Okra pods	*(Hibiscus esculentus)*
Peony foliage	*(Paeonia spp.)*
Pine, Scots (bleached and natural)	*(Pinus sylvestris)*
Unicorn pods	*(Proboscidea louisianica)*
Yarrow	*(Achillea* 'Gold Plate')

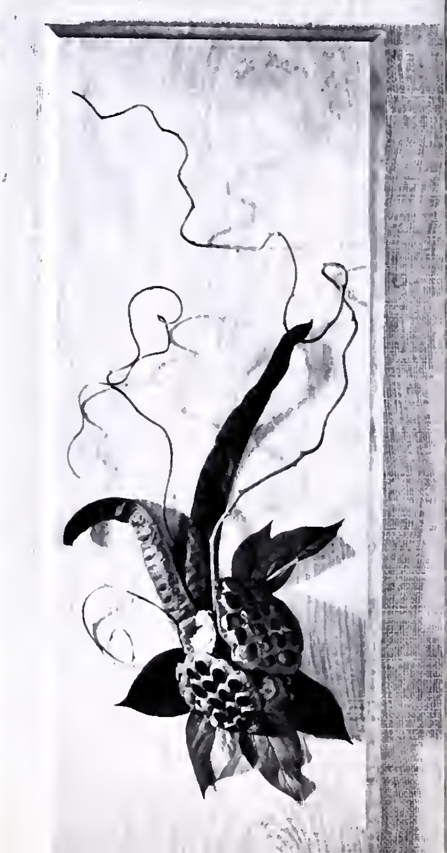
Designs by Shirley Brooker.



Plaque on Wooden Board Plant material used:

Bittersweet branches (dried)	*(Celastrus scandens*
Coconut perianth	*(Cocos nucifera*
Honey-locust pods	*(Gleditsia triacanthos*
Lotus	*(Nelumbo spp.*
Peony foliage (glycerined)	*(Paeonia spp.*

Photographs by James C. Fish



For Christmas—and other special occasions

WREATHS AND SWAGS

Barbara Laking

Wreaths and swags have been great favorites for decorating churches and homes at Christmas, and are sometimes designed for parties and other festive occasions. Traditional Christmas wreaths and swags are usually made with a base of evergreens, decorated with water-repellent bows or an assortment of cones, fruits and bows. For other occasions attractive wreaths and swags can be made with cones and fruits, with or without bows, or with dried flowers and foliage and contrived flower forms.

Wreaths

Wreaths and swags made with evergreens are the quickest and easiest to make for outdoor use.

Materials—An ordinary wire coat hanger or heavy wire can be bent into a circle, but it is much better to start with a ready-made wire frame of two circles or more, especially made for the purpose and available from florist supply houses and garden centers. These range in size from 8 to 36 inches in diameter. Frames made from one circle of crinkle (waved) wire are also available.

Other materials—A spool of No. 26 florist wire, 18-inch lengths of green wire in various gauges, such as 18, 20, 22, florist tape (green and brown); wire cutters.

Construction—To prevent the evergreens from slipping on the wire frame, cover the wire surface with florist tape. Attach a piece of No. 20 wire to the frame to serve as a hanging device. Cover with florist tape. Cut evergreens into 4 6-inch lengths. Attach the end of a roll of No. 26 wire to the frame. Then place one piece of evergreen at the back of the frame, two or three pieces on top of the frame to form a small bunch and wind the No. 26 wire firmly, several times, around bases of shoots only. Always work in the same direction. Repeat the process, overlapping the lower part of the stems of the previously attached evergreens until the entire circle is completely covered.

Usually an evergreen wreath is improved with a bow. Many beautiful colors and varying widths are available in water-repellent ribbons from which attractive bows can be fashioned.

An evergreen wreath may be decorated by wiring on a variety of cones and fruits, or a cone wreath may be superimposed on the evergreen wreath.

Evergreen Swags

Swags can be quickly constructed from evergreen branches tied together in a pleasing form. For slender branches it helps to use a piece of wood 1½ inches wide and about 10 inches long to serve as a backing for the swag. Swags, as described above for evergreen wreaths, may be trimmed with cones, nuts and water-repellent ribbon.

Designing and Making Cone Wreaths

A tremendous amount of interesting material—cones, nuts and fruits—is available to create distinctive cone wreaths. Beginners might start with a design motif of three, five or seven properly-balanced, equidistant centers of interest. The largest cones can be used in these positions, and they can be cut into flower forms (as described below) or wired upside-down to create special interest. Work in the smaller materials in pleasing designs around these main areas. At the Royal Botanical Gardens we often make continuous circles of cones, carefully selected for similarity of size and color, around the inner and outer edges of the wreath, and fill in the remaining area with a

Wreath made of various kinds of fruits and nuts and different sizes of cones, some of which have been cut. Ribbon bows have been added for color and texture contrast.

planned design. Cover the "mechanics" (wires) with 3-inch width of green nylon net around the underside of the wreath, attaching it with small lengths of bent wires. Cover the whole wreath with a clear plastic spray. Cone wreaths may be trimmed with water-repellent ribbon. When not in use, store the wreaths in plastic bags in a dry place.

Materials—Wire frames are available in many sizes. A useful, average-size frame is 14 or 16 inches across with 2 or 3 inches of wire rings. The latter make a deeper base. Other materials include a spool of No. 26 florist wire, 18-inch lengths of green wire in various gauges, florist tape (green and brown), wire cutters, sharp pruning shears, needle-nosed pliers, electric drill, green nylon net (3-inch width).

Construction—Attach a piece of 20-gauge wire to frame to serve as a hanging device. Cover with florist tape. Attach the end of a roll of No. 26 wire to the frame. Place moist sphagnum moss in the frame, a handful at a time, packing it firmly. Wind the No. 26 spool wire firmly around the moss. Add more moss, wire it; repeat until the whole circle is filled with moss and securely wired. It is very important to make a firm base to enable the design of cones and fruits to stay in place. Allow moss to dry out thoroughly before binding with green nylon net.

Wiring Cones—Cones of various sizes are used in the designs. Use No. 20 wire for wiring the majority of cones. No. 22 or No. 26 can be used for the small cones.

Insert a 9- to 12-inch length of No. 20 wire under the scales at the stalk end of a cone, leaving a 1- to 1½-inch length sticking out in an upright position in the area of the stalk. Continue working the remainder of the wire under the lowest scales until you reach a position opposite the starting point. With needle-nosed pliers twist the 1- to 1½-inch end around the longer length of wire, until wire is firmly attached to the cone.

Cutting Cones—Cones may be cut (at right angles to the main axis) with sharp pruners to simulate daisy-like flowers. Another flower form can be created by exposing the under surface of the basal segment of the cone.

Drilling and Wiring Nuts—Use an electric drill for making fastening holes in nuts, cones, fruit pits and acorns. Drill through these near their bases, making two holes. Cut No. 20 wire into 6-inch lengths and insert through both holes. Using pliers, twist short end of wire around longer length until wire is firmly attached to the base of the nut. All prepared materials are then wired to the mossed frame of the wreath. Each wire is inserted through the moss and the end bent back into the frame.

Designing Swags

Imaginative designs may be made from the fascinating plant materials—nuts, cones and fruits—available to us today. Materials of interesting lines help to create rhythmic movement. Usually a center of interest is established—as described above for wreaths—sometimes more than one, and smaller materials in pleasing designs are then worked around these main areas.

Materials—The materials for such

swags consist of a length of green chicken wire (1-inch mesh), moist sphagnum moss, a spool of No. 26 wire, 18-inch lengths of green wire in various gauges (18, 20, 22), florist tape (green and brown).

Construction—Place the moist sphagnum moss along the whole length of the chicken wire (size of swag governs length), about an inch from the edge. Pack firmly. Roll the chicken wire tightly over and over the moss. Turn in cut ends of chicken wire at the top and bottom ends of the swag. Bind entire base with No. 26 wire. Shape the swag into desired form. Allow to dry thoroughly before covering with nylon net. Attach a hanging device.

PLANT MATERIAL FOR WREATHS

Cones and Cone-Like Fruits

Alder	*(Alnus spp.)*
Cedar of Lebanon	*(Cedrus libani)*
Cedar, Deodar	*(Cedrus deodora)*
Douglas-fir	*(Pseudotsuga menziesii)*
Hemlock, Canada	*(Tsuga canadensis)*
Horsetail Beefwood	*(Casuarina equisetifolia)*
Pine, Austrian	*(Pinus nigra)*
Pine, Loblolly	*(Pinus taeda)*
Pine, Longleaf	*(Pinus palustris)*
Pine, Mugho	*(Pinus mugo)*
Pine, Ponderosa	*(Pinus ponderosa)*
Pine, Red	*(Pinus resinosa)*
Pine, Scots	*(Pinus sylvestris)*
Pine, Eastern White	*(Pinus strobus)*
Spruce, Norway	*(Picea abies)*
Spruce, White	*(Picea glauca)*

Nuts, Pods and Other Fruits

Acorns	*(Quercus spp.)*
Brazil Nut	*(Bertholletia excelsa)*
Eucalyptus	*(Eucalyptus spp.)*
Hazelnut	*(Corylus spp.)*
Hickory Nut	*(Carya ovata)*
Honey-locust	*(Gleditsia triacanthos)*
Horse-chestnut	*(Aesculus hippocastanum)*
Lotus (pod)	*(Nelumbo spp.)*
Magnolia	*(Magnolia spp.)*
Milkweed	*(Asclepias syriaca)*
Okra (pods)	*(Hibiscus esculentus)*
Pecan	*(Carya illinoensis)*
Sweet-gum	*(Liquidambar styraciflua)*
Trumpet Vine	*(Campsis radicans)*
Walnut	*(Juglans spp.)*
Wisteria, Chinese	*(Wisteria sinensis)*

Evergreen Foliage for Wreaths

Boxwood, English	*(Buxus sempervirens)*
Fir, Balsam	*(Abies balsamea)*
Douglas-fir	*(Pseudotsuga menziesii)*
Juniper, Pfitzer	*(Juniperus chinensis* 'Pfitzeriana')
Juniper, Golden Pfitzer	*(Juniperus chinensis* 'Pfitzeriana Aurea')
Juniper, Tamarix	*(Juniperus sabina* 'Tamariscifolia')
Pine, Eastern White	*(Pinus strobus)*
Yew, Japanese	*(Taxus cuspidata)*

NOTE: Never use hemlock or spruce shoots if the wreath or swag has to last for any length of time. The needles fall very quickly.

James C. Fish

Stylized version of a swag. A base has been provided, similar to kind used for plaques. Swags can be hung with or without backgrounds.

Shade-tolerant flowers for drying

PLANTS FOR A SHADED GARDEN

Most of the plants whose flowers or fruits are used in drying are sun-dwellers, but the homeowner with a shaded garden need not be discouraged. Here is a selection of outstanding shade-tolerant perennial plants that are suitable for drying. Most are available from local nurseries or from mail-order sources. For keyed listings of nursery sources and garden descriptions see the two special issues of *Arnoldia* (Vol. 34, No. 5; Vol. 35, No. 1) on Low Maintenance Perennials. Each issue costs $2.00 and is available by mail order from the Arnold Arboretum, Jamaica Plain, Massachusetts 02130.

Flowers Best Dried by Silica Gel

Bellflower	*(Campanula spp.)*
Common Bleeding Heart	*(Dicentra spectabilis)*
Virginia Bluebells	*(Mertensia virginica)*
Day-lily	*(Hemerocallis spp.)*
Long-spur Epimedium	*(Epimedium grandiflorum)*
Blue Lungwort	*(Pulmonaria angustifolia)*
Fragrant Plantain-lily	*(Hosta plantaginea)*

The flowers of the colorful astilbe hybrids (mostly *Astilbe* x *arendsii*) are best air-dried.

Pods and Seedheads for Air-Drying Method

Purple Coneflower ("cones" make excellent centers for contrived flowers)	*(Echinacea purpurea)*
Gasplant	*(Dictamnus albus)*
Blue Wild-indigo	*(Baptisia australis)*
Common Rose Mallow	*(Hibiscus moscheutos)*
Masterwort	*(Astrantia major)*
Snakeroot	*(Cimicifuga racemosa)*

George Taloumis

Snakeroot *(Cimicifuga racemosa)* is a tall-growing perennial for shady situations. The flowers appear in summer and are followed by the seedheads in fall.

Flowers of the day-lily, a rewarding summer-blooming perennial for both shaded and sunny situations, can be preserved by using the silica gel method.

Volunteer group in Ontario raises flowers for drying to help the Royal Botanical Gardens

A GARDEN OF FLOWERS FOR DRYING

Elaine N. Corbet

MOST GARDENERS are usually satisfied to grow a few of the traditional plants for drying along with other annuals and perennials, but as enthusiasm increases it may become desirable to have a separate garden for them. This is appropriate if fairly large quantities of flowers are needed for drying, for flowers such as annual statice and many others must be picked as soon as the blossoms reach perfection. In fact, a well-run plot of flowers grown just for drying is singularly lacking in color all summer long because of constant picking, so it should be situated in an inconspicuous area, perhaps as a section of a vegetable garden.

In 1967 the Women's Committee of the Royal Botanical Gardens in Hamilton, Ontario, formed a group of dried flower enthusiasts to supply the needs of the Gardens' Floral Art Shop. The work of the Dry Flower Committee is sometimes strenuous, but it is rewarding to its members, giving pleasant outdoor exercise with good companionship, and, above all, the knowledge that it is helping to provide the Gardens with additional financial support for special purposes.

Some of our experiences may be of interest to gardeners everywhere, especially to other volunteer groups and gardeners who would like substantial amounts of flowers for dried arrangements.

Our special plot in the Botanical Gardens is 150 feet by 150 feet. It lies on a gentle sunny slope and has moderately good soil. A 4-foot wire fence surrounds the plot and extends down into the ground to discourage ground hogs and other animals. There are two gates, one large enough to admit a tractor or truck, the other for volunteers who do most of the work. We have a watering system with overhead sprinklers, a particularly good aid because drainage on the slope is very sharp.

Plans for the growing season start in January. Seeds of many annuals suitable for drying are ordered by mail from a number of firms so as to get a selection of plants in various colors. An arrangement is then made with a local commercial grower to sow most of the seeds in his own greenhouse. About 90 flats, each containing 48 young plants, are needed. We deliver the seeds to him in February with a list of the number of flats of each plant required, along with a letter confirming the price per flat and the delivery date to us for planting-out. In our area this is about the third week in May, after all danger of frost has passed.

We check with the grower at least twice to find out what has germinated and what has not so there will still be time to buy more seeds if necessary. It is best to provide him with more seeds than perhaps are really needed because he may be unfamiliar with some of the less commonly grown plants. The grower is provided with a distinctive label, a bright yellow plastic tag for each flat. We write these labels ourselves, indicating seed source, plant name and flower color. Some seeds are also given to our own members who start them indoors under artificial light or in a cold frame. (For instructions on starting plants in the home, see Brooklyn Botanic Garden HANDBOOK OF ANNUALS.)

A detailed plan of the plot done to scale on squared paper is prepared. From this plan, paths and planting areas are marked off on the ground with colored nylon cord. Perennial plants are kept at one side of the plot. There are 3-foot

Photographs by George Taloumis

Blue salvia and French marigolds make an attractive display in a summer garden. Spikes of blue salvia retain their color when dried by the air-drying method.

paths running the full length of the plot between the rows so a mechanical cultivator can be used to cut down on hand weeding. Clumps of rangy perennials such as 'Gold Plate' and 'Coronation Gold' yarrow, for example, are planted every 3 feet in the rows, while sea-lavender (known also as perennial statice) can be more closely spaced.

A larger section of the plot used for annuals is divided somewhat differently. Three-foot paths alternate with spaces 2 feet wide which accommodate two staggered rows of plants. Each plant is one foot apart in all directions. As they grow, this close spacing cuts down on weeding and allows the plants to support each other so staking is not necessary. Double rows of tall plants such as strawflowers alternate with rows of lower-growing annual statice or larkspur to allow for better circulation of air and greater ease of harvesting. Plants from one seed source and of one color are kept together and marked so it can be decided whether they are good enough to grow again another year.

Planting-day

Planting-day must be well planned. The flats are brought to the gardens the day before and are well watered with a 20:20:20 fertilizer. Volunteers are divided into teams. One team works at a table, carefully taking the plants from the flats and passing them out on trays to the planting team. This team is provided with rulers and trowels and their work is directed and checked by an experienced gardener. Another team follows to water. Seeds planted directly in the ground are taken care of another day. We have no trouble getting enough help for planting-day as it is one that the volunteers find most enjoyable. It is not so much fun later when the weeds start to grow and the weather gets hot, but a boy is hired for a few hours a week to help with the heavier work.

About three weeks after transplanting, the annuals are fed again, this time with a 5:10:15 fertilizer, and once more in another three weeks. Annual plants grown for drying purposes seem to be heavy feeders and we find it wise to also add generous amounts of manure in the early spring, well before planting-day. Spraying is important and must be carried out at regular intervals throughout the summer. (As with all insecticides, manufacturers' directions are followed carefully.) Aphids attack rose-everlasting and tarnish plant beetles will sting strawflowers, causing misshapen buds. We are also plagued by a small beetle that comes indoors on the strawflowers and chews them during the winter.

The watering program for a volunteer group project has to be carefully thought out because most of these plants, particularly statice with its small root system, require a great deal of moisture. Flowers for drying must be picked frequently, but never when wet. Try to water one day and pick the next or, depending on the size of the plot, it may be possible to water half the plot and pick the other half on the same day. Picking every day is something to aim at, but generally not practical.

When the last picking is completed, the Royal Botanical Gardens' staff cleans up the plot for us and sows winter rye grass, which is later turned into the soil to provide an excellent source of humus.

Here is a list of plants that our volunteer group grows and finds satisfactory. Included are notations of interest regarding each one, with approximate height. An *asterisk* denotes plants that may need staking if grown in a flower border instead of a special plot. Virtually all require sun most of the day for best performance. All except okra and corn are started in a greenhouse or cold frame. Many other useful dried materials are brought to the workshop by our members from their own gardens. No attempt is made to list these here, nor is there any mention of the large quantities of goldenrod, Queen Anne's-lace and other common wayside plants that are also gathered for drying.

Ageratum *(Ageratum houstonianum)* Annual, 3-12 inches, spreading. A common edging plant. Dwarf forms with strongest blue color dry best. Strip the foliage, bunch the flowers and hang them up to dry.

Silver King Artemisia *(Artemisia albula* 'Silver King') Perennial, 2-3 ft. The soft gray, feathery leaves of this ornamental wormwood, which is grown strictly for its foliage, serve to blend colors together and are helpful when filling a silver or pewter container. Plants are rugged and can be cut almost to the ground as soon as full growth has been made, but they require excellent drainage. Bunch and hang the stems.

Preserve celosia flowers by stripping foliage, loosely bunching stems and hanging to air-dry. Both crested and plume forms are used.

Baby's-breath *(Gypsophila paniculata)** Perennial, 3-4 ft. The tiny white flowers give a light, airy look to an arrangement. We like the double-flowered 'Bristol Fairy' and 'Snow White'. Pick at the peak of bloom, separate the flower stalks, and hang them upside down. We never seem to grow enough of this useful plant. Invaluable in dried flower wedding bouquets (of which we make many). The annual species don't dry well.

Chinese Lantern *(Physalis alkekengi;* synonym: *P. franchetii)* Perennial, to 2 ft., easily raised from seed. Grown for the bright orange calyx, a swollen pod about 2 in. long. These "lanterns" may be split open to give a flower-like effect. Cut before autumn weather spoils them. Strip and hang. Best grown in a separate plot because plants can be invasive in the flower border.

Cockscomb *(Celosia argentea* forms) Annual, 6 in. to 3 ft. Both the crested and plume forms are useful. Grow yellows and orange reds, not blue reds. Strip, bunch and hang.

Garden Delphinium (various species

When drying delphinium flowers, cut spikes when all but top one or two flowers are open.

and hybrids)* Perennial, often short-lived, 2-6 ft. Raise plants from seed started the previous summer and select only the spikes with strongest, brightest blue flowers. Pale blue, pink and mauve colors become gray when dried, and most purples are too dark. White turns an unattractive cream. Nothing, however, can exceed the beauty of a well-dried spike of vivid blue delphinium. Of the candle delphinium types *(D. elatum)* such as the Pacific Hybrids, dry the ones having white centers ("bees"). The dark "bees" when dry give a drab look to the flowers.

To dry, cut spikes when all but the very top flower or two is open. This may mean that some of the lowest flowers have passed; strip them off with the leaves. The spikes are placed upright and well separated (a large glass frog or metal cage-type flower holder is good for this) until the individual flowers are almost dry. Then the spikes are turned upside down and suspended on hangers so the tips will dry straight. It may be necessary to gently straighten the tip. Side shoots and second blooms are both useful. When completely dry, delphinium stores well in long florist boxes with each spike separated by tissue paper. Our delphinium plants are grown in the Gardens' nursery as our own plot is too windy.

Globe-amaranth *(Gomphrena globosa)* Annual, 2 ft. Flowers resemble a large clover. Seed is usually a mixture, producing white, pink and purple blossoms. Yellow comes separately and is really a very attractive pale orange. When the color is well developed, pick, strip and hang. Before using, the stems should be taped to keep the flower heads from drooping in humid weather. Globe-amaranth thrives on manure.

Grasses, Ornamental

Cloud Grass *(Agrostis nebulosa)* (1 ft.)

Quaking Grass *(Briza maxima)* (1-2 ft.)

Hare's-tail Grass *(Lagurus ovatus)* (1 ft.)

Fountain Grass *(Pennisetum villosum)* (1-2 ft.)

The above species, except fountain grass, are annual. It is far more satisfactory to buy ornamental grass seeds in separate, not mixed packets. If picked while the furry heads are still green, hare's-tail grass will keep that color. All grasses should be cut while green so that they will hold together when dry. Hair spray or clear plastic spray will also help this.

Honesty *(Lunaria annua)* To 3 ft. Treat as a biennial. Sow seeds in summer for the succeeding year's fragrant purple-to-white flowers and striking pods. Pick the pods, which resemble silver dollars, when they mature, but before autumn rains cause discoloration. Remove outer part of pod to reveal the silvery partition. The outer parts are valuable for making petals for contrived flowers. Glue them into the center of a dried purple coneflower *(Echinacea purpurea)* or a small pine cone.

Common Immortelle *(Xeranthemum annuum)* 3 ft. This annual with an attractive small flower is one of the few that must be fully open before picking. The

Above: The graceful wands of purple fountain grass contrast with the rounded yellow flowers of African marigolds. The grouping provides summer display in the garden as well as cut flowers for fresh bouquets or dried arrangements. **Right:** The airy flower heads of lady's mantle can be air-dried for winter use.

blossoms, which somewhat resemble cornflowers, are available in mixed colors. Strip, bunch and hang.

Lady's Mantle *(Alchemilla major* of gardens) A strong-growing variant of a compact, shade-tolerant herb. Leaves are pleated and resemble a fan. The 18-in tall stalks bearing tiny, star-shaped, lime-green flowers appear in early summer, last a long time and may be air-dried.

Larkspur *(Delphinium ajacis)* Annual, 1-2 ft. We grow the earliest-blooming sorts because the stems of the plants often suffer mildew later in the summer. All flower colors, available in mixtures or separate shades of white to pink and violet, dry extremely well. Larkspur can be troublesome to grow, performing best in areas with cool summers, but it is well worth the extra effort. We use all we can harvest. Strip, bunch only a few stems together, and dry them on hangers.

Lonas *(Lonas annua;* synonym *L. inodora)* Annual, 1 ft. Resembles a small yarrow but sometimes sold under the misleading names of African-daisy and yellow-ageratum. Keeps its yellow flower color well and is useful in small arrangements. Pick when stems start to burn bronze and the small blossom heads are still hard. Pick the larger center head first and smaller stems later. Bunch and hang. (See Diagram 3.)

Okra *(Hibiscus esculentus)* Annual, 4-6 ft. This vegetable has attractive yellow flowers with red centers but is grown in the drying garden for its striking pods, which are well spaced on strong stems. The pods are also used singly (sometimes split) in wreaths or plaques. To hasten maturity, remove side shoots and cut tops off when stems attain 3½ feet. Remove some leaves to allow sun to reach pods. Cut the whole plant off at ground level before frost. After drying, some okra will remain green. May also be dried in full sun, which will bleach it to honey-beige color. Turn frequently to avoid mildew. Before drying, pods to be used singly should have a 20-gauge wire put through the stem at a right angle to it and close to the pod. Bring ends of wire together and twist them to form a new support.

Rose-everlasting, Rose-sunray *(Helipterum roseum)* Annual, 2 ft. Sometimes sold as *Acroclinium.* Comes in shades of pink to rose and white. The colors are clear and the center stays yellow if these daisies are picked just before fully open. Cut the entire stem and tape it as for globe-amaranth. This everlasting is one of the first plants to be harvested. Humboldt sunray *(H. humboldtianum),* to 1½ ft., is quite different, producing clusters of small yellow flowers. Strip leaves, bunch and hang.

Blue Salvia *(Salvia farinacea)* Perennial in mild climates; grown as an annual in cold ones. To 3 ft. Spikes of blue flowers do not drop if picked at their peak. Grow a cultivar of strong color such as 'Regal Purple'.

Giant Sea-holly *(Eryngium giganteum)* A strong-growing perennial, to about 3 ft. Leaves deeply cut and sharp to the touch. The gray-green flowers with their showy calyces are striking in a dried arrangement. Air-dry them. Another species, *E. amethystinum,* growing to about 18 in., is more widely available and might be tried, too.

Wide-leaf Sea-lavender *(Limonium latifolium)** 2½ ft., spreading to 3 ft. A perennial statice useful for its softening effect in an arrangement. Pick when the tiny mauve flowers are fully open. Hang stems until dry.

Narrow-leaf Sea-lavender *(Limonium tataricum angustifolium;* synonym, *L. dumosum)* Another perennial statice, to 1 ft. Wait until all the mauve flowers, including those on the tips, are open before you pick. The stems grow in a tangle and must be carefully separated before drying. The petals fall off as the stems dry, but the calyces form hundreds of tiny white stars. The plant is a strong grower but has graceful curved stems and gives arrangements a special flair. It is a must in any plot of flowers for drying. Can be grown from seed, producing an abundance of bloom the second summer. In our area this sea-lavender is protected in winter with discarded Christmas trees. Frost may heave the plants; check for this in early spring and firm into the ground if necessary. We grow over 200 plants and use the whole crop.

Annual Statice *(Limonium sinuatum)* Biennial, grown as an annual, 2 ft. Individual stems are picked when the flower color is showing well right to their tips. Cut frequently as blossoms pass their peak quickly. Strip off any large leaves, bunch only a few stems together, and hang. Requires good ventilation while drying; thicker-stemmed cultivars tend to mildew. The following have been good here: 'Iceberg', 'Midnight Blue', 'Heavenly Blue', 'True Blue' and 'Rosea'. For yellow, grow *L. bonduellii. L. suworowii* produces thin pink or lavender spikes which are useful, but it does not do well in heat. Spikes of poor color may be dyed.

Strawflower *(Helichrysum bracteatum)* Annual, 4 ft. One of the most popular plants for drying. For good-sized flowers *H.b. monstrosum,* which is the commonly cultivated double-flowered form, is grown in yellow, white, pink, salmon and rose. Red and bronze tend to be too dark. Seed packet mixtures give pale yellows and bright oranges that are not obtainable in separate colors. Pick the flower stems in bud stage—well before the blossoms open fully—and wire before drying. Place upright in any container with ample room for the heads to spread out as they dry. When completely dry, put together in bunches of 12 with small elastic bands and fasten to a clothes hanger. (See diagram on page 4.) Store in an airy place away from direct sunlight. Can be kept unwired for a few days in a paper bag (*not* plastic) in the refrigerator.

Golden-Thistle *(Centaurea macrocephala)* Stout, upright, summer-blooming perennial, growing to 3-4 ft. Foliage is coarse but the conspicuous yellow flower heads, about 3 in. across, dry well if cut early. The pineapple-like bracts which open out later are strong and of good color and shape. For air-drying.

Strawberry Corn *(Zea mays,* in one of several ornamental forms) Annual, 5-6 ft. Develops small dark red, strawberry-shaped cobs. If necessary it can be picked before color develops. Fold back husks, but leave them attached to cob.

Unicorn Plant *(Proboscidea louisianica;* synonyms *P. jussieui, Martynia proboscidea)* Annual, 3-4 ft. Grown principally for its odd-shaped fruit, a curved beaked capsule which has many decorative purposes. Pick fruit when hard. Remove outer covering as it dries, into two claw-like, curved ends, about 3 in. long. Soft, unripened fruit may be pickled like a cucumber.

Winged Everlasting *(Ammobium alatum grandiflorum)* Annual, 3 ft. Member of the daisy family (Compositae) with 2-in-wide white flower heads. The yellow centers often turn brown. Pick each flower on its own short stem before fully open; don't wait for all the flowers on one branch to be ready. Tiny buds dry well for use in miniature arrangements. Bunch and hang, but stems must be taped to keep the heads from drooping when used in arrangements.

Yarrow *(Achillea filipendulina)** Perennial. Both *A.f.* 'Gold Plate' (4½ feet) and the hybrid 'Coronation Gold' (3 feet) dry well. If picked too early the large, showy, flat clusters of flowers will shrivel. If left too long the color will not be perfect. Pick as soon as the individual flowers making up the cluster separate slightly. They should feel firm and give the same appearance as a fresh cauliflower with its "bloom." We use the flowers from about 300 clumps of yarrow in a year. The soft gold color blends with many other dried flowers and their size helps when making up a large arrangement in a hurry.

Sneezewort Yarrow *(Achillea ptarmica)* Perennial, 2 ft. Another species, but with loose clusters of white flowers, mostly double. Several cultivars, including 'The Pearl' and 'Perry's White' are available. The clusters dry well but tend to turn cream by Christmas. Dye them in simmering Tintex or Rit for soft colors. (Roots were once used for snuff.) ☘

The colonial housewife used dried flowers because she had so few winter-blooming plants . . .

EIGHTEENTH-CENTURY WINTER BOUQUETS FOR A WILLIAMSBURG SETTING

Joan Parry Dutton

It may be that Colonial Williamsburg's revival of an eighteenth-century tradition has contributed to the popularity of dried flowers today. Arrangements of dried flowers have been a part of the interior decoration of the houses open to the public since 1932, and they have been observed by millions of visitors.

Dried-Flower Tradition

Precedence for the tradition is found in the writings of two hundred years ago. Philip Miller, curator of the Chelsea Physic Garden in London, was well aware of the increasing love for flowers in the house. In his *Gardener's Dictionary* he wrote: "Varieties of the Elichrysums and Xeranthemums, will make a curious Variety of dry flowers for Basons to adorn Rooms in the Winter Season, when few other kinds are to be had."

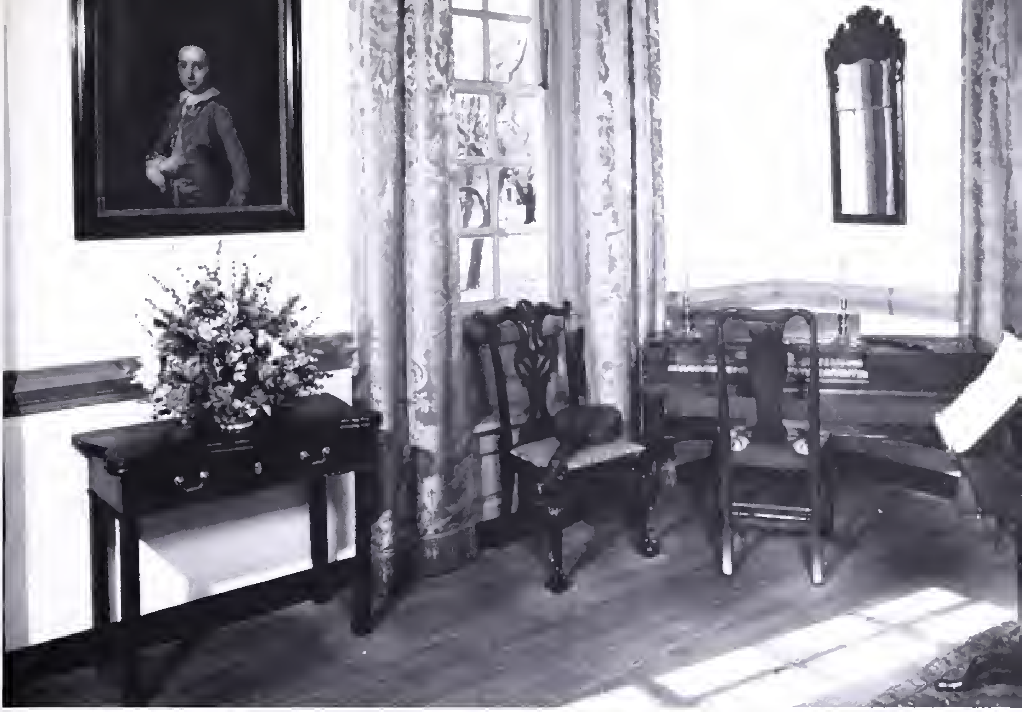
Nowadays Elichrysums are known as Helichrysums, commonly called strawflowers. Xeranthemums, for which there is no truly common name, like strawflowers, are also known as 'everlastings' or 'immortelles' because their flower parts retain form and color for long periods. These, Miller recorded, were "Brought to the Markets in great Plenty during the Winter Season."

Philip Miller's *Gardener's Dictionary* was first published in 1731 and went into eight editions, the last in 1768. This dictionary was the standard reference for gardeners in England and in the American colonies. Thomas Jefferson recommended its inclusion in the books for a gentleman's library, and in Virginia it had an honored place on gentlemen planters' bookshelves.

This book may have encouraged the drying of certain plants for winter use in the colonies, or perhaps the custom was simply a matter of remembering what was done in England. Whichever, we know that pearly everlasting *(Anaphalis margaritacea)* which grows widespread in both Europe and North America, was so used. Peter Kalm, the Swedish naturalist, while staying with John Bartram near Philadelphia in September 1748, saw it growing in astonishing quantities upon all uncultivated fields and hills. Kalm knew the plant as *Gnaphalium margaritaceum,* and it was Bartram who presumably told him that "The English call it 'life everlasting,' for its flowers, which consist chiefly of dry, shining, silvery leaves do not change when dried."

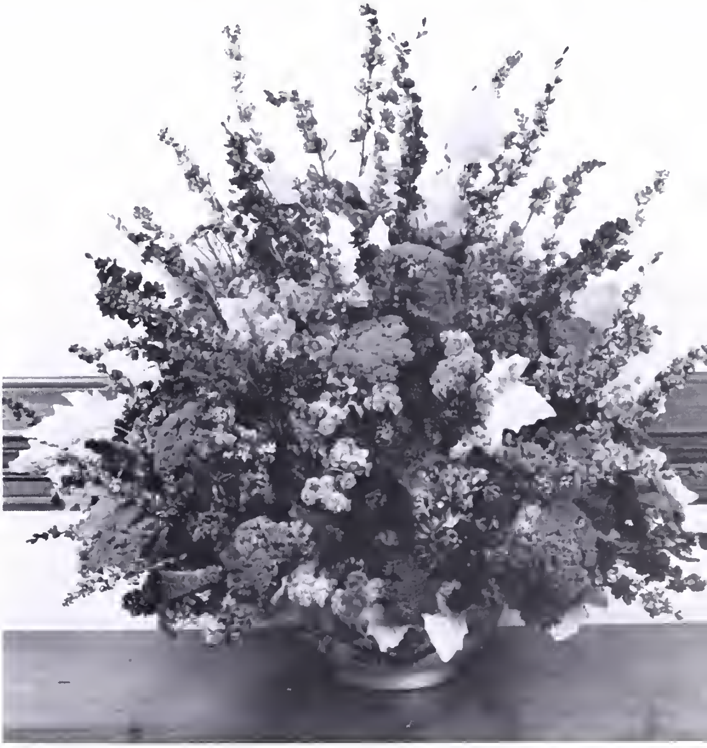
Kalm added: "The English ladies are accustomed to gather great quantities of this life everlasting, and to pick them with the stalks. For they put them into pots, with or without water, amongst other fine flowers, which they gather in the gardens and in the fields, and place them as an ornament in the rooms. The above-mentioned Gnaphalium was one of those which they kept in their rooms during the winter, because its flowers never altered from what they were when they grew in the ground." (From Peter Kalm's *Travels into North America.* 1770)

In England, one of the most popular 'everlastings' was the globe-amaranth *(Gomphrena globosa)* which was introduced from India around 1714. A little-known reference to its use is found in the correspondence between Peter Col-



Photographs by Frank J. Davis, Colonial Williamsburg Foundation

The bouquet at right is shown in its setting in a Colonial Williamsburg room. Dried flowers used include light and dark blue larkspur, strawflowers, cockscomb, hydrangea, yarrow and goldenrod, and those two useful fillers, pearly everlasting and feverfew. The container is an English porcelain bowl made in Worcester about 1770.



Bouquet on opposite page in its Colonial Williamsburg bedroom setting.

linson of London and John Custis of Williamsburg from 1734 to 1746. Collinson sent seed of the plant, which he called *Amaranthoides*, to Custis time and time again. In 1742 Custis at last wrote triumphantly that one seed came up, and shot into a multitude of branches and bore more than 100 flower: came out daily till the frost stopt them; I esteem it one of the prettyest things I ever saw."

Collinson wrote back: "I am much Delighted to heare you have your amaranthoides. It is a Real & I may say perpetual Beauty. If the flowers are gather'd in perfection and hung up with their Heads Downewards in a Dry shady Room, They will keep thear Colours for years and will make a pleasant Ornament to Adorn the Windows of your parlor or study all the Winter. I dry great quantities for this purpose and putt them in flower potts & China basons & they make a fine show all the Winter."

So much for precedent.

Properly, everlastings are plants whose chaffy or papery flower parts hold their color when thoroughly dry. In today's revival of the use of dried plant material, a vast array of either wild and cultivated flowers are used, as are ferns and grasses, corn tassels, wheat and barley ears, and leaves. In Williamsburg, only those plants known to the eighteenth-century plantsmen are used.

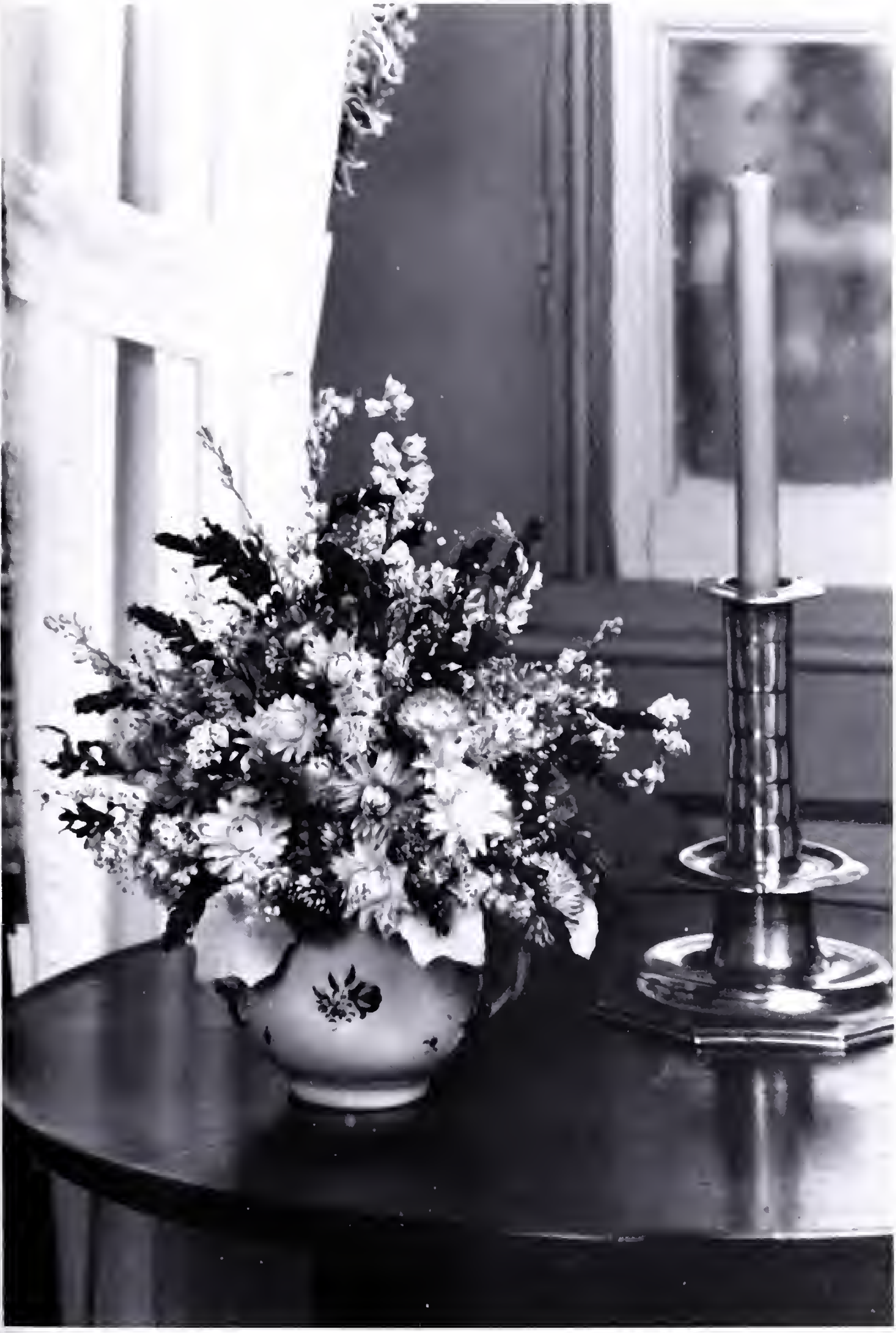
Dried Flowers at Williamsburg

Colonial Williamsburg's flower staff dries its plant material in much the same way as did Peter Collinson. The drying room is an attic over a kitchen, in which temperature slightly warmer than that of the outdoors is maintained. And because everlastings, like fine wine, mature best in isolation and darkness, the small windows are covered with black cloth. Wires are strung from wall to wall and from them the flowers are hung, head downward, immediately after being gathered. (See centerfold of this Handbook for photograph.)

For a good harvest, the material is gathered from June through October. Many plants bloom intermittently through summer and autumn until frost, so no definite time can be fixed for their reaping. And as dried-flower enthusiasts know, harvesting at the right moment is as important as having a proper drying room.

Colonial Williamsburg's flower staff follows Philip Miller's advice, too, in filling the containers with sand, taking care to use fine sand. This is their only *aid* for holding the material in place. No record of eighteenth-century use of modeling clay or wire is known, and there was no paraffin wax or borax then. But some of the period's containers had built-in aids, since they were designed especially for cut flowers.

Queen Mary, wife of King William III of England, for whom Williamsburg was named, loved flowers in her rooms and asked that containers be made for that



Bedside arrangement of white larkspur, strawflowers, boneset, scarlet sage, baby's-breath and poplar leaves. Bouquet is shown in its bedside setting on the opposite page.

This pewter bowl, placed on a desk, holds dried yellow yarrow, goldenrod, feverfew and pokeberries.

purpose. Being a queen, she got what she asked for, and at the same time created what was to become a potter's item much in demand. There followed, long after Queen Mary was gone, a wide range of containers, which culminated in Josiah Wedgwood's productions of "bouquetiers of red and white biscuit," "flower jars purple and green enameled, vases and bough pots," "dice-worked flower pots," vases with spouts that "keep the flowers distinct and clever," to name but a few.

Because of King William's and Queen Mary's association with Williamsburg—they granted a charter for the College of William and Mary and a generous endowment for its support—it is fitting that the Colonial Williamsburg Foundation has a significant array of containers. They come in pewter, glass, brass, and even of wood; but for the most part the vases and bowls are of pottery and porcelain. So are the small round, square, oblong, or triangular "bricks" with openings to hold the flowers in place.

It may come as a surprise that there is no traditional eighteenth-century style, nor any record, to date, of set rules for making fresh or dried flower arrangements. Even the term of flower *arrangement* is comparatively modern. Thus the flower staff of Colonial Williamsburg follows no set rules, although its members do follow certain guidelines that people with a flair for artistry have followed consciously or unconsciously for centuries. They know that the container must either blend with, or stand out in contrast to, the colors of the fabrics within the room; and that the size or scale of a finished arangement should be determined by the space it will occupy.

We should remember that not every colonial housewife, by any means, possessed more than one or two special flower containers; nor did the English housewife. Many would have used, just as we would use today, a soup tureen, a mug, a pewter bowl, or a similar item in regular household use. And they would have picked whatever flowers, herbs, or greenery were at hand to brighten up their rooms. Some of the arangements in the houses in Williamsburg's Historic Area are extremely simple, especially those consisting of greenery and fresh flowers. The dried flower arrangement is inevitably more studied and more stiff and formal. ☙

BOOKS FOR FURTHER READING

Barbara Laking

Dutton, Joan Parry. *The Flower World of Williamsburg.* Williamsburg, Virginia: The Colonial Williamsburg Foundation. 1973. Distributed by Holt, Rinehart and Winston, New York.

This is a revised edition, with 40 new illustrations. Mrs. Dutton's delightful presentation enables one to enjoy the Williamsburg gardens and the eighteenth-century flowers that beautify these gardens and enrich the decor of the historic buildings. One learns how the blossoms were preserved in this era, what kinds of containers were used and what gave the gracious displays their own distinctiveness. There are chapters on "Dry Arrangements for Winter," "Knowing Your Flowers" and an excellent representative list of trees, shrubs, flowers, vines and herbs.

Hame'l, Esther Veramae. *Creative Designs with Dried & Contrived Flowers.* New York: Simon & Schuster. 1971.

Creativity and how flower arrangers achieve it is well presented in this inspiring book. Also covered is every known process of preserving flowers and foliage. Her chapter entitled "Contrived What-Is-It" challenges one to be creative in many different ways.

MacDermot, Elizabeth. *The Art of Preserving Flowers; A Guide for Canadians.* Toronto: James Lewis & Samuel, Publishers. 1973.

This book is an informative guide to the art of preserving flowers. It is easily understood with its illustrated step-by-step procedures. Comprehensive lists of plants for preserving are extremely useful.

Vance, Georgia S. *The Decorative Art of Dried Flower Arrangement.* Garden City, New York; Doubleday & Company, Inc. 1972.

With this well researched book you learn how and what to use to create the kinds of dried flower arrangements practiced in various historical periods. The photography is superb. The art and technique of flower and foliage preservation is skillfully presented. Included are excellent lists of plants to preserve. ⁂

Strawflowers, pink and white larkspur, cockscomb and pink globe-amaranth have been set in a crocus pot and placed in a corner bookcase with curved shelves. The pink larkspur and globe-amaranth give a rosy glow to the whole arrangement.

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l. 30 No. 4
(Winter 1974-75)

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BROOKLYN BOTANIC GARDEN RECORD
PLANTS & GARDENS

Vol. 30 Winter 1974-1975 (March 1975) No. 4

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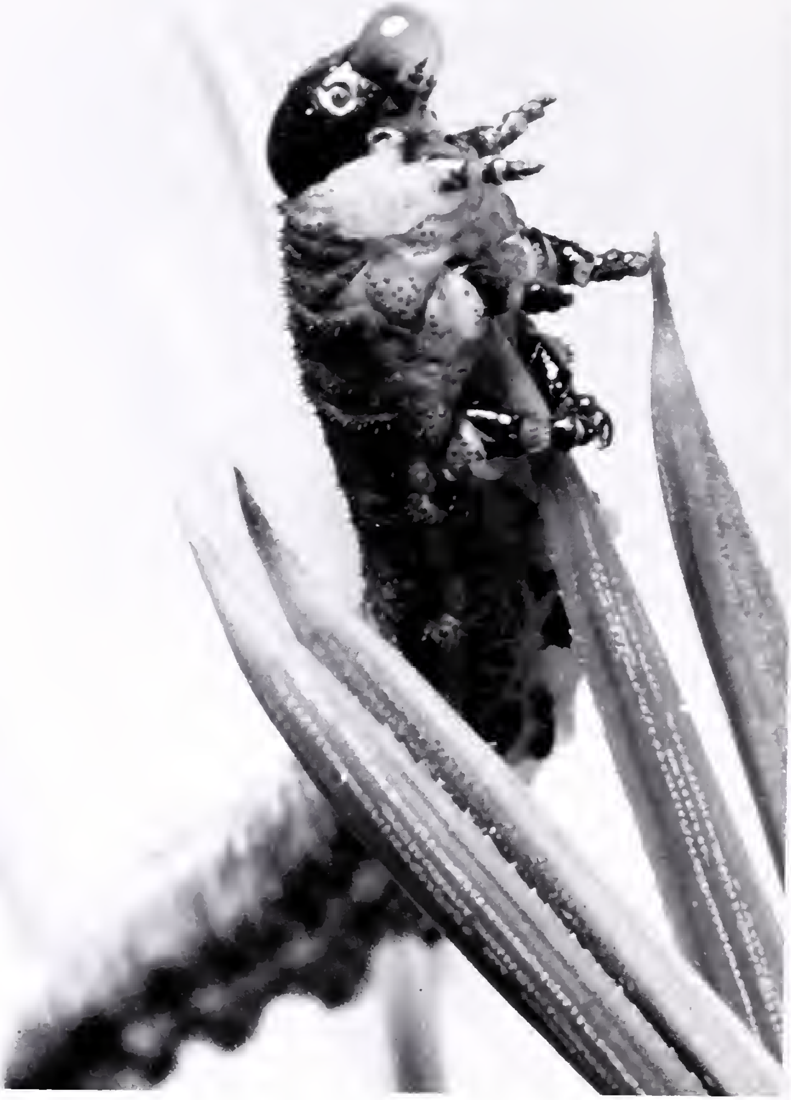


Thomas Eisn

A group of scientists at Cornell University, led by Thomas Eisner, has discovered th larvae of the European sawfly can store resin, obtained as they feed on pine needles, f later regurgitation to dab on natural enemies, such as ants, spiders and birds. The res is stored in two pouches behind the mouth and released in droplets as the enemy arrive Then the larva revolves its body to dab the deterrent fluid on the intruder, causing it flee. The larva shown above is about to release resin. Results of the discovery we described in *Science*, May 31, 1974 (Vol. 184).

LETTER FROM THE BROOKLYN BOTANIC GARDEN

Every fourth issue of PLANTS & GARDENS is devoted essentially to the selection of outstanding articles that have appeared in other publications in the previous year, and 1975 provides no exception to this type of "digest," which has found great favor with readers who like to see the broader spectrum of horticulture. Let us thank authors and publications who have given us permission to reprint articles. Our warmest appreciation also goes to the contributors of original articles in this issue.

In addition, we are indebted to article-clipping readers who draw our attention to special-interest pieces they think should be shared with members and subscribers. One of B.B.G.'s good friends on Brooklyn Heights who travels widely in the course of a year occasionally sends us an article that has caught her eye in a California newspaper or a British or French periodical. (We often plot her travels that way!)

Another reader, John Wister, who is one of the venerable deans of American horticulture (and a former P & G editor), sends us a piece from time to time. Dr. Wister, known to many as Mr. Lilac, Mr. Iris, Mr. Native Plantsman or Mr. AABGA, depending on the particular society he has helped foster over the last 60-or-so years, is keen on wildflower preservation these days—as he always has been. See page 26 for Janet Gyer's article, which Dr. Wister thinks (and we strongly agree) should receive your scrutiny.

If during your garden reading in the next year you come across a truly outstanding short article in a newspaper or other local publication, do a favor and send it to us with notation on date, periodical and publisher's address. Make sure, however, that the article has a fairly broad national application. Naturally, it won't be possible to include everything, but such material can help in the selection process, since our "f"-to-"b" Library (full-to-bursting), which receives 500 different horticultural and botanical journals, has no space for newspapers. Sometimes, real gardening pearls appear in them, and it would be nice to share them with other readers.

Maybe there should be a P & G citation for quote of the year, too. Every so often, one hears a phrase that sticks in the mind like beggar-ticks on a collie. We remember one that was quickly uttered by someone a couple of years ago at a rock garden meeting in Connecticut, about the danger of 'wet feet' to plants—"Good drainage never hurt anything but a sphagnum bog!" Let's give the 1975 award to Professor Lee Snyder of the University of Missouri. Asked about the pop fad of talking to plants, he remarked: "The only benefit is the increased air circulation blowing around the leaves as you speak." (In a more serious vein, see Dr. Galston's article on page 4.)

Cartoon of the year?—And have you noticed how many cartoons on the plants-have-feelings theme have popped up lately? With an apology to the highest-minded respecters of the birds and the bees, and to the foes of anthropomorphism, I think my vote would go to one sent by a reader in Georgia. It showed a flower backing away from a bee, with the caption "Not now, dear, I have a headache!"

Let's go back to the truly natural world in its prettiest season. Spring is coming to the Botanic Garden again and the wealth of floral display is greater than ever, it seems. The Japanese Hill-and-Pond Garden, which we think with only a mite of partiality is the finest of its kind in North America, is celebrating its 60th anniversary this year. It is exceptionally beautiful just now but worth a visit any time of year. The pleasure that this gift of Mr. Alfred T. White has given visitors in the half-century plus ten cannot be measured, but the Japanese Garden is one of the most strikingly effective examples of public philanthropy by a private citizen in the history of the Botanic Garden. It has been visited by more than 50 million people.

Spring is a time of transition, too, in nature and at the Garden. On the P & G scene, this means the retirement of Miss Frances A. Damm after 29 years, during the last fifteen of which she has served as Secretary of Publications. A master of intricate detail who has overseen the distribution of 76 different Handbooks to home gardeners around the country, she has brought many good friends to the Botanic Garden fold and has helped to personalize the institution in the best possible way. Frances, best wishes to you in retirement in the hills of northern New Hampshire, and may all your peas be sweet peas. Also, our warmest greetings to your successor at B.B.G., Violette Connolly.

Come to think of it, may all *your* peas be sweet peas, too—except for a few bucketfuls of the edible kind for the legume pot in summer. Let the harvest be a good one in this Year of the Home Vegetable Garden!

Sincerely,

Frederick McGourty, Jr.

Editor

P.S.

Members know about it but many of our subscribers don't, so let's mention B.B.G.'s latest contribution to the cinema art! *Nature's Colors—The Craft of Dyeing with Plants* won the top award in the Film Festival held at the American Horticultural Society Congress last autumn. The 11-minute documentary, which is in color, is ideal for meetings of garden clubs and other horticultural groups. For information on rental or purchase of *Nature's Colors* and three other B.B.G. films (subjects: pruning; planting and transplanting; bonsai), write Film Library, Brooklyn Botanic Garden, Brooklyn, New York 11225.

By ignoring accepted rules of evidence, the authors of a popularized book on plants reach many false conclusions

THE UNSCIENTIFIC METHOD

Arthur W. Galston

From Natural History, March 1974

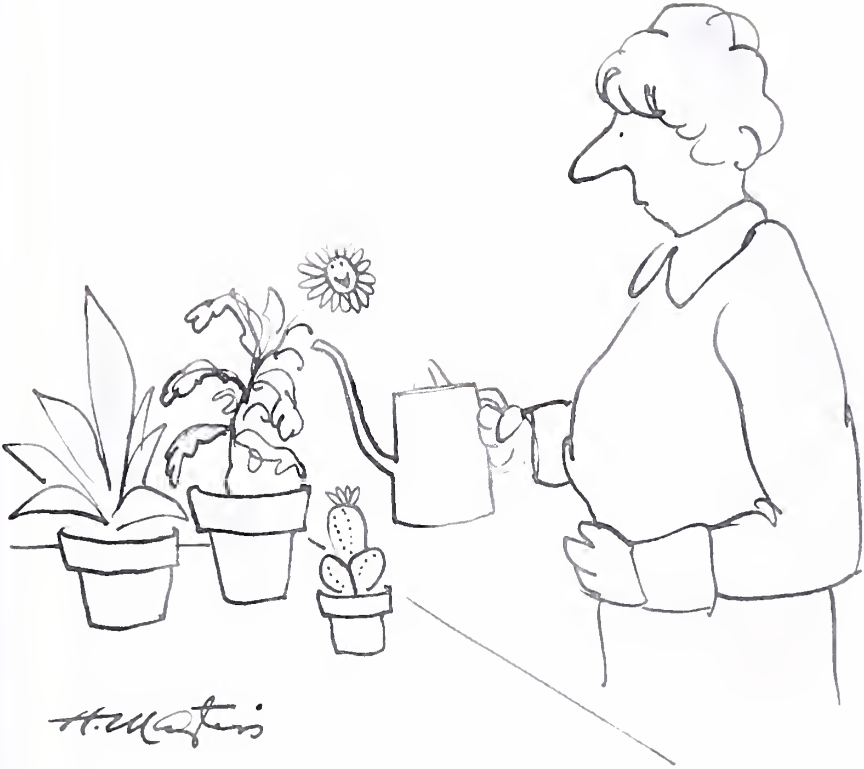
Did you know that plants can respond to human speech, thoughts, emotions, and prayers? That they are capable of purposeful alteration of their behavior? That they can count, communicate with each other, and receive signals from distant lifeforms on other stars and in other galaxies? That they can respond selectively to certain forms of music, develop conditioned reflexes, and predict cyclones, tornadoes, earthquakes, and volcanoes? Did you know that plants have accomplished the dream of the alchemists: transmuting one element into another? And did you know that you can rid plants of insect pests or fertilize the soil in which they grow simply by exposing pictures of the growing plants to particular frequencies of electromagnetic radiation? All this, and lots more, is laid out for you in *The Secret Life of Plants,* written by Peter Tompkins and Christopher Bird, and recently published by Harper and Row.

How can any two reasonable authors advance so many patently false, unprovable, or impossible conclusions? The answer is by ignoring all the ordinary rules of evidence and by damning, circumventing, or flouting the scientific method whenever is serves their purpose to do so.

The experiments of Cleve Backster on electrical phenomena form the foundation for much of what Tompkins and Bird have written. On December 11, 1973, Backster, a former CIA polygraph expert, told the *Christian Science Monitor* (page 9, 2nd section): "The only problem in this kind of research is that Mother Nature doesn't want to jump through the hoop ten times in a row simply because someone wants her to. It's difficult to structure repeatable experiments. There are some phenomena that occur that make this kind of thing very difficult. For instance, once you are sure something will happen, it very well may not. I suspect that's because you are communicating to the biological material as long as you keep your consciousness involved in the experiment."

Isn't that neat? According to that explanation, anyone doing experiments can "prove" anything he wishes simply by getting a result once—or perhaps once in a while. What about the times the experiment doesn't work? Mother Nature is just being a little coy. What about another experimenter who tries to repeat your work and can't? Well, that person may not have the proper mental attitude or may not be properly attuned to the plant being employed. As Marcel Vogel, another Tompkins-Bird hero who is trained in electronics but not botany, puts it: "Hundreds of laboratory workers around the world are going to be frustrated and disappointed . . . until they realize that empathy between plant and human is the key, and learn how to establish it. No amount of checking in laboratories is going to prove a thing until the experiments are done by properly trained observers. Spiritual development is indispensable. But this runs counter to the philosophy of many scientists, who do not realize that creative experimentation means that the experimenters must become part of their experiments."

Well, that at least is putting it squarely and honestly. What do you want to believe? Results that are obtained when carefully described experiments are repeated by competent investigators anywhere in the world? Or results that can be obtained only by a select few in



Henry Martin

"I'm fine, thank you, Mrs. Cooper, and how are you this morning?"

"special contact" with their test material? Scientists are well acquainted with results that occur only occasionally. They have learned that under such circumstances it is easy to fool yourself into thinking you have obtained a positive result, when all that has really happened is that a random variation, either in biological material or experimental conditions, has cropped up. It is therefore an unwritten rule not to believe anything until you have been able to repeat it several successive times. And when both negative and positive results are interspersed, it is necessary to resort to appropriate statistical procedures to validate or at least describe the uncertainty attached to any conclusion that seems to flow from the data.

It is also axiomatic among scientists not to really trust any results that have been reported successful in only one laboratory. Published results must describe the experiments and organisms in such detail that conscientious researchers elsewhere can get approximately the same results. When the same results are produced several times in different laboratories, scientists begin to accept the original conclusions. But no answer in science is considered absolute, final, or immutable. Everything is challengeable and nothing is sacred. Through such hard-nosed procedures, science has come up with generalizations and procedures that have transformed all aspects of our physical and intellectual world.

This is not to say that flashes of intuition are ruled out as a valid means of inferring the truth about nature. The nineteenth-century German chemist Kekulé, long puzzled about the structure of the benzene molecule, is said to have formulated his now widely accepted ring structure for benzene after dreaming about a snake swallowing its tail. But without subsequent experiments to support it, the dream-derived intuition would have been of little value to Kekulé. The situation is the same today. Ideas are relatively cheap. It is only through experiments that test their validity that they acquire scientific value.

The trouble with *The Secret Life of Plants* is that it consists almost exclusively of bizarre claims presented without adequate supporting evidence. Thus, if the unwary reader believes much of what Tompkins and Bird have set down, he will be cluttering his mind with mythology rather than science. And if the reader attempts to order his life on the principles and generalizations they put forth, he will be led seriously astray.

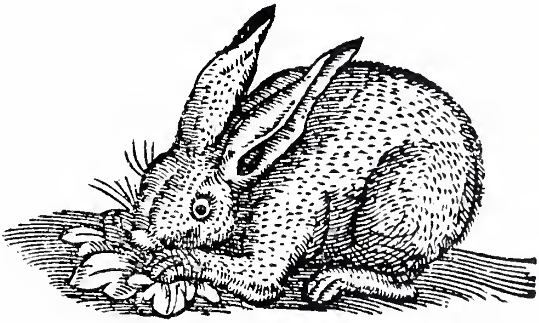
As a professional plant physiologist, concerned with an analysis of such plant-life processes as flowering, leaf movements, rhythmic behavior, and hormonally controlled growth, I can only react with incredulity to the Tompkins-Bird description of botany: "Why botany, a potentially fascinating subject dealing with plants, living and extinct, their uses, classification, anatomy, physiology, geographical distribution, should have been from the beginning reduced to a dull taxonomy, an endless Latin dirge, in which progress is measured more by the number of corpses cataloged than by the numbers of blossoms cherished, is perhaps the greatest mystery in the study of plant life." This statement stems either from ignorance or from willful misrepresentation. For the study of botany, as almost any university catalog in the subject spells out, is precisely the study of plant structure, function, distribution evolution, physiology, and biochemistry Taxonomy, so castigated by the authors is an essential foundation for the understanding of plant group relationships and evolution. Some of the data may seem dull to gather, analyze, and read about but in their relation to evolutionary thought, they furnish character and plot to one of the most exciting and elegant stories ever told.

To say, as the authors do, that "what makes plants live, or why, does not appear to be the purview of science" is to pretend that vast libraries of books on plant physiology, growth, and development do not exist. I have an eighteen-volume encyclopedia on the subject of plant physiology in my office, as well as more than twenty-five textbooks and monographs. Each year we learn more about the structure and chemical composition of plants; how they grow, metabolize, and change; why they go into and out of dormancy; why leaves turn color and fall; and why plants become senescent. Indeed, plant physiology is now the largest branch of botany. Can Tompkins and Bird be innocent of this information?

The authors obviously know some science, but they present it in such a fragmented and selected form as to create consistently incorrect impressions. For example, they mention the experiments of the late Alexander Gurewitsch, a Russian biologist who claimed to have proved that dividing cells emit "mitogenetic radiations" that cause other cells to divide, and they cite only other investigators who agree with him. They say nothing about the crucial experiments of Alexander Hollaender, the retired former head of biology at Oak Ridge National Laboratory, which disproved the existence of mitogenetic radiations. They attribute to L. Ron Hubbard, a former science fiction writer and the founder of Scientology, the discovery that light from sodium vapor lamps is harmful to plants. This information was described many times before Hubbard's mention of it, and its basis is well understood.

A contemporary Russian, Panishkin, is cited as evidence for the conclusion, surprising to the authors, that some plants do not flourish in uninterrupted light; they also need some darkness. References to similar work abound in the literature of plant physiology and are even cited in many textbooks, including my own. The authors talk about plant rhythms without ever mentioning Erwin Bünning, the distinguished German plant physiologist who spent his whole life investigating their physiology and establishing their significance. They talk about day length without mentioning Garner and Allard, the researchers who discovered photoperiodism, and they are apparently ignorant of the existence of the pigment phytochrome, which plays such an important role in this process. They describe certain experiments in plant bioelectrics without mentioning the bulk of the recent work in the field. They are flatly wrong when they say that the plant growth hormone, auxin, is "summoned and even transported by the cell-generated electric fields to the place where growth is known to occur." This was disproved several years ago by the work of Grahm and Hertz in Sweden, but Tompkins and Bird are obviously not familiar with the recent literature.

In time, the effects of this book will fade away—you can't fool too many people for too long a time. Meanwhile, some plant lovers will croon to their cattleyas and murmur to their mimosas. This may comfort the vocalizers, but it won't do anything for the plants . . . unless Tompkins and Bird have more hard evidence than they have yet shared with us.



Drury

THE VEGETABLE-SPAGHETTI

Helen T. Crispe

ONE of the most unusual and interesting plant novelties appearing in seed catalogs these days is a squash called vegetable-spaghetti. As the name suggests, the inside of this vegetable, when cooked, separates into spaghetti-like strands, with a flavor midway between summer and winter squash. This oblong-shaped, whitish-skinned squash is about 8 inches long and 4 inches in diameter when ripe. It is grown in much the same way as winter squash and performs best in rich soil to which well-rotted manure or compost has been added. Full sun is desirable.

In the New York area the seeds may be planted quite early (near the end of April) if they are covered with Hotkaps (little tents of waxed paper), which help warm the soil and protect the seedlings from late frost. By starting at this time one can begin harvesting around the last week of July. The seeds should be planted in hills or groups, spaced about 5 feet apart in each direction. After germination, thin the seedlings to four plants per mound or group. The fast-growing vines of this squash easily invade neighboring plants if not checked. Turning back the vines toward the center of the patch helps confine them. Each plant is quite prolific. One or two mounds will give several fruits every week from late July until frost. The only major pest is the squash borer. Control early by spraying with Sevin; follow manufacturer's directions and precautions carefully.

Recipes

There are several ways to prepare this vegetable. One is to steam it in 2 inches of water in a tightly covered pot, for about one hour, or until soft. Then cut the squash in half lengthwise and serve with butter and salt after removing seeds and outer skin. (For those patient enough to bother, the inner "meat" of the seeds is nutlike in flavor and texture.) Another method is to boil for only 20 minutes, then cut in half and scoop out the seeds; stuff with a mixture of ground beef and tomato sauce, and top with cheese. I like to use mozzarella but grated parmesan is also satisfactory. Bake at 350° F. until the squash can be easily pierced with a fork. Served this way the vegetable becomes a unique "spaghetti" dinner.

Among the seed sources for vegetable-spaghetti are: Nichols Garden Nursery, 1190 N. Pacific Highway, Albany, Oregon 97321; George W. Park Seed Company, Greenwood, South Carolina 29646; Stokes Seed Company, Box 548, Buffalo, New York 14240. ☙

What flies with its hands, sees with its ears and sleeps hanging upide down?

THE BAT

Lewis Rems

From Naho, Summer 1974 (New York State Museum and Science Service)

Along the edge of the Helderberg escarpment, the winter blows cold. With the temperature in the teens and a foot of snow on the ground, it seems both an unlikely time and place to be looking for bats. My partner and I, though, are doing just that as part of a survey of the bat populations of Albany, Schenectady, and Schoharie counties of New York State. We have come to the Helderbergs where caves abound, hoping to find a roost of bats which now, at mid-winter, would be comfortably hibernating and would not be disturbed by our presence. At the bottom of a sinkhole called the Clarksville Cave, there is a small opening. We crawl through its narrow entrance, round a corner in the passage, and a moment later we are in total darkness.

When we turn on our flashlights, the rugged limestone features of the cave's interior jut out at us and cast long shadows down the twisting corridor. We point the beam toward the ceiling and there, clustered like so many bunches of dried raisins, hangs a colony of bats. Ordinarily, such a sudden onset of bright light would frighten the bats and send them flying about in frantic confusion, but now they are sound asleep. If I wanted, I could easily pick one off its perch on the ceiling without affecting its slumber.

These are big brown bats, a hardy species that can withstand the cooler temperatures at the mouth of the cave. Different species of bats have different temperature and humidity requirements for hibernation, often a segregation of species, both in the part of the cave where they are found and in the height at which they sleep.

The temperature in the cave hovers between 40 degrees and 45 degrees F year around which, coupled with the comparative safety of total darkness, provides an ideal environment for bats. But for us, as we work our way to the back of the cave where the majority of the bats have congregated, it is too warm, so we shed the heavy winter wear so necessary for outside.

Ten species of bats occur in New York State and adjacent New England: little brown bat (*Myotis lucifugus*); Keen's bat (*Myotis keenii*); Indiana bat (*Myotis sodalis*); least brown bat (*Myotis subulatus*); Silver-haired bat (*Lasionycteris noctivagons*); Eastern pipistrelle (*Pipistrellus subflavus*); big brown bat (*Eptisicus fuscus*); red bat (*Lasiurus borealis*); Seminole bat (*Lasiurus seminolus*) and the hoary bat (*Lasiurus cinereus*).

Of the ten, the red, the silver-haired and the hoary bats are migratory, departing for more southerly climates each fall and returning north each spring. In some instances, whether intentional or accidental, these bats travel along with migrating flocks of songbirds. Of the other seven species, the Indiana bat is becoming rare, and the Seminole bat is only a casual visitor to our region. Any of the remaining five can be found wintering in caves throughout New York State.

In our cave, the bats near the entrance are big browns, about 4 to 5 inches long with a wingspan of about 12 inches. But as we work our way back further, identification becomes more difficult. The *Myotis* group—the little brown bat, the Keen's bat, the least brown bat, and the Indiana bat—are all difficult species to separate by external character-

A resting red bat, in the usual upside-down position. Before bats can fly, they must drop through the air, then take flight before hitting the ground. This is a basic reason for the upside-down resting or sleeping position.

John H. Gerrard from National Audubon Society

istics. All are varied, all of the same general size (about 3 to 4 inches with a wingspan of 7 to 8 inches), and unless they are viewed alongside the other species in a good light, it is almost impossible to distinguish one from another. We are satisfied to classify these bats only in the genus *Myotis*. However, in the warmest part of the cave we both notice a pair of Eastern pipstrelles. This tiny bat weighs no more than a good-sized moth and is of a noticeably lighter shade, almost a yellow-brown. It is one of the deepest sleepers and requires the warmest hibernation temperatures. We note their presence and, our count completed, make our way back to the entrance, leaving the cave in the darkness that we found it.

Facts or Myths?

Darkness is the proper environment of the bat, not only in a literal sense, but also figuratively, for the history of the bat is one clouded by fear and superstition. Popular tradition holds that bats, when enraged or frightened, will cling to a person's hair and never let go; that bats drink human blood; that the bite of bats causes madness; that bats are creatures of the devil (in popular art, Satan is often portrayed with bat's wings).

Most of these tales are based on a certain measure of truth, blown out of proportion. Some bats do, in fact, drink blood. The vampire bat of Mexico and Central America inflicts a small wound, then laps up the blood, but its activities are almost always limited to animals such as cattle or horses. Bats are carriers of rabies, but then so are many other wild creatures, and the number of cases of rabies directly attributed to bats is small.

The common fear of the bat may have stemmed from the inability of our ancestors to classify it. Was it a mammal? A bird? A combination of the two? If the latter, it was an unnatural creature and therefore, by inference, a thing of evil.

Bats have been with us since early Eocene time— that is about 60 million years ago. The only mammals to have evolved true flight, they probably started as small, tree-climbing insectivores, adapting to flight through the elongation of the fingers and the development of loose folds of skin between them to form wings. Among the orders of mammals, the bats rank second only to rodents in number and diversity of species. About 900 species are recognized, in 18 fami-

Woodrow Goodpaster from National Audubon Society

A big brown bat in flight. It is a year-long resident of most of the Northeast.

lies. By far the greatest number live in the tropics. They also abound in temperate climates, but being nocturnal and usually small and secretive, they rarely attract attention or arouse curiosity.

Since most bats are insect-eaters, and since the greatest period of insect activity is after sunset, bats do not rely upon their weak eyesight for food or navigation. Instead, they have developed an elaborate sonar system to locate and track their prey, find their way to and from their roosts, avoid obstacles and even monitor their altitude. They emit rapid bursts of sound, intensely loud, but of high frequency; then they interpret the echoes. In this way they can assess the distance, direction, movement and possibly identify the objects reflecting the sound. This sonar system is called "echolocation," or "acoustic orientation" by scientists.

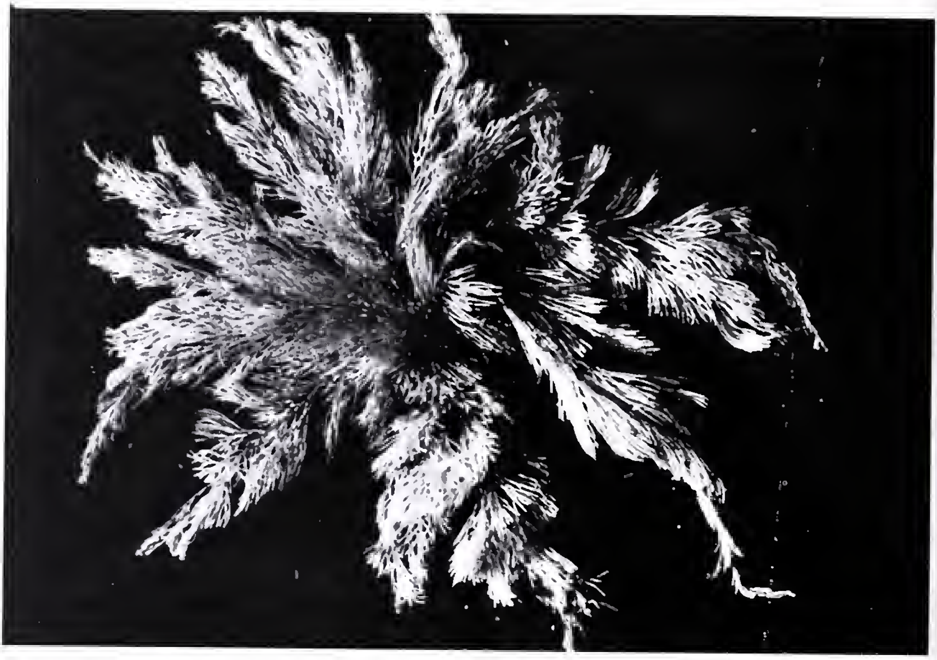
Using echolocation, a bat can catch so many insects so rapidly that a mere half second may elapse between identification and capture. This split-second timing makes a bat's flight path appear highly erratic. Bats catch insects in flight by mouth and by wing. When an insect hits the bat's wing the bat gathers it to his mouth as if with a hand.

Behaviorists are studying echolocation in bats. By understanding how bats accomplish such complex maneuvers in movement and in catching their prey, they hope to gain some insight into how man's brain processes sensory information.

Born in the late spring, young bats are nursed by their mothers until able to fly. But in order to fly a bat cannot run or jump for a take-off; they must drop from a surface and achieve flight before they hit the ground. This is a basic reason that they hang suspended from some object.

The life cycle of a bat is an unceasing round of hunting and resting. Bats seek caves, old houses, steeples, or any roost that provides darkness for sleep and protection. Emerging from their roosts shortly before or after sunset, they spend the nighttime consuming huge quantities of insects, A big brown bat may devour as many as 1,000 insects in an hour. When dawn breaks, the bats return to their shelter where, hanging upside down, they slumber until evening comes again. This cycle is broken only by either migration to the south in winter or by hibernation in some stable temperature environment such as a cave, until a combination of body physiology, light, temperature, and insect activity starts the whole cycle again. Like most small mammals, bats are not long-lived. The average life span may be anywhere from 3 to 10 years, depending on the species.

By consuming vast numbers of insects, bats fill an important ecological niche. Because of their sophisticated sonar system they are of increasing interest to scientists studying both human and animal behavior. Certainly there is nothing to fear from this small, harmless creature as it flits about on a summer's evening in its seemingly erratic, but purposeful flight. ⁂



Claire Etienne

DO YOU KNOW THE AIR-FERN?

Elizabeth McClintock

From the CALIFORNIA HORTICULTURAL JOURNAL, October 1974

"THE AIR FERN, a live miracle, decorative house plant . . . thrives on the air surrounding it . . . lives indefinitely without water or soil. The Air Fern looks like a beautiful green fern plant but isn't . . . it's a living substance."

So reads one of the advertisements seen in various parts of the country during the past ten to fifteen years. Other advertisements call the material by such other fanciful names as "aqua-fern," "Neptune-fern" or "magic fern." The advertisement quoted dates from 1967 and the material offered cost only forty-nine cents, not an exorbitant price for something completely misrepresented. After spending forty-nine cents and receiving this "live miracle," two things were apparent: the "living substance" was no longer living and it was certainly not a plant! The advertisement was correct in at least one point: it was not a fern.

Curious as to what the material might be I consulted one of my colleagues, an invertebrate zoologist, Dustin Chivers, who identified it for me as *Sertularia argentea*, a hydroid of the phylum Coelenterata to which corals and sea-anemones also belong. In addition I learned that this material, obviously no longer living, had been dyed a bright green. (After several years it has faded to a dingy mustard-green.)

Sertularia argentea is found off the coasts of eastern North America and western Europe. It is the basis of a small industry in the Thames Estuary of England. The floor of the estuary is combed with iron rakes which pick up colonies of the hydroid. This material is treated, dyed, and packaged to be sold.

Reference

TUCKER, ARTHUR O. and SHARON S. TUCKER. 1974. Identification of the "Air Fern." Sold in the United States. Baileya 19:114-115. ☘

The greenhouse in winter—a time when the price of fuel soars.
George Taloumis

With the current prices of fuel, greenhouse owners must be especially conscious of techniques for insulation and maintenance that will keep costs within bounds

CONSERVING FUEL IN THE GREENHOUSE

Harold E. Gray

From Under Glass, March-April 1974

Heat loss in a greenhouse results primarily from conduction through the glass and air leakage. Using figures for Albany, N. Y., it appears that a "cool" 50-degree greenhouse would require about half the fuel of a "warm" 60-degree house over a heating season, all other factors being equal.

Conserve heat, first, by growing "cool" rather than "warm" plants. Whatever you grow, run the temperature a little on the low side. Although growth may be slowed, many plants can get along fine with a few degrees less than optimum.

Lowered temperatures result in some interesting effects: insect activity in general is less with cooler temperatures. Some plants will not flower below a certain temperature, so you can drop the thermostat during non-flowering periods without harm. (Lists of temperature requirements for plants are published in a "Handbook for Greenhouse Gardeners," available from Lord & Burnham, Irvington, N. Y. 10533.)

One effective method of reducing heat loss through conduction is by insulating with a dead air space. The simplest method is to install an inner layer of plastic—either thin film such as polyethylene, or a rigid type such as fiberglass. Keep the air space "dead," that is, seal it sufficiently so convection currents are not possible between the layers.

A good hermetically sealed second layer could reduce conducted heat loss by up to 40 percent, but 20 percent is more realistic because of the problems of installation. The inner layer of plastic will reduce light transmission to some extent, but the plastics manufactured for greenhouse use today cause minimum light reduction.

A glass-to-ground greenhouse loses substantially more heat than a conventional wall greenhouse of the same size and shape. To conserve heat, the glass wall portion can be lined with a solid board, either plywood or one of the composition insulating boards attached directly to the inside face of the bars.

There are many areas of potential air leakage in the greenhouse. Many greenhouses with vents are automatically controlled from a separate thermostat. The setting on this thermostat should be 5°

to 10° higher than the heater thermostat to assure the vents will not open when the heater is on.

All vents present a problem of potential leakage at the point of closure. This can be greatly reduced by installing weatherstripping. Many soft foam rubber or synthetic strips, with adhesive backing, are available and can be easily applied. If the vents are not to be used in the winter, they can be completely covered and sealed tight with inexpensive polyethylene sheets.

Awning windows louvers, and fan openings are other potential sources of heat leakage. These can easily be sealed over with polyethylene, since they ar not likely to be used in winter.

Doors must usually be kept free t operate, but leakage can be minimize by proper weatherstripping across the to and at the sides. Above all, be sure tha a good sweep is installed at the bottom.

The wind has a marked effect on hea loss. Wind screens can help to reduc this loss. In choosing a location for new greenhouse, a location with natura wind shelter should be sought. Lean-t models to be installed next to the hous can be located in a sheltered sunny nook Be wary of such a nook, however, wher snow whirls in and accumulates. ❧

HOME GREENHOUSE COURSE COVERS DESIGN, CONSTRUCTION AND USE

A thorough briefing in the most important aspects of building and using a home greenhouse is available from Penn State in the form of a home correspondence course.

The booklet is written by Dr. Robert A. Aldrich, associate professor of agricultural engineering at Penn State. It includes six lessons: Choosing the Site and Type; Heating and Ventilating; Inside the Greenhouse; Plastic and Sash Greenhouses; Greenhouse Management; Flowers You Can Grow.

It can be ordered by writing to Correspondence Courses in Agriculture and Home Economics, 202 Agricultural Education Building, Pennsylvania State University, University Park, Pa. 16802 and asking for course #139, "The Home Greenhouse," also enclosing a check for $1.75.

SOLAR HEAT SOURCE FOR GREENHOUSES

Edward Romney described his solar-heated, insulated mini-greenhouse in the May, 1974, edition of OGF, using double-layer plastic to allow the sunshine and heat in and keep it in.

This past winter he added this design feature for added heat:

"We lined the back with a full stack of aluminum soft drink cans filled with water. They're taped shut with electrician's tape to keep the water from evaporating, and held in place with nails and coat hanger wire.

"They collect heat during the day and give it off at night. The cans can get quite warm in sunlight. Water stores more heat per pound than iron according to physics tests. The vegetables are growing faster, too."

It may help to paint the cans black to increase their heat retention.

—*Organic Gardening and Farming*, September 1974

The lilac-colored 'Leopold II' has been found to be among those lilacs that are most severely injured by the air pollution of cities.

Photographs by George Taloumis

LILACS FOR CITIES

C. R. Hibben and J. T. Walker

THOSE old-time garden favorites, lilacs, are in trouble in the northeastern United States, particularly around cities. The peculiar malady that is afflicting them may be recognized late in the summer by several characteristics: a rolling or curling of the foliage; scorch marks between the veins of the leaves and on the leaf edges; browning of the undersides of the leaves; and the early dropping of the foliage. Shrubs losing their canopy of leaves sometimes produce a second flush of leaves and flowers late in the growing season. Because of the characteristic symptoms, we have named this the leaf roll-necrosis of lilacs, abbreviated LRN. There is strong evidence that this malady is a result of air pollution.

Members of the Kitchawan Research Laboratory of the Brooklyn Botanic Garden, Ossining, New York, have completed an investigation into the causes of LRN of lilacs. The ultimate health of lilacs, not to mention other forms of plant and animal life, depends on our willingness to cleanse the air in cities and suburbs. Until that occurs, however, a partial solution to the problem is to plant certain kinds of lilacs that are now known to resist air pollutants.

From our early studies it was learned that microbial disease agents, insects and mites, nutrient deficiencies, herbicide injury, graft incompatibility, soil acidity and water shortages were not primary causes of LRN. However, as our research progressed, injury by air pollutants was suspected because some of the leaf markings on lilacs were typical of those caused by pollutants on other kinds of plants. Previous tests at the Botanic Garden in Brooklyn confirmed that plant-injurious air contaminants indeed occur in New York City, as they do in most urban areas.

Several experiments showed that air pollutants were likely contributors to LRN of lilacs. For example, current-year stem cuttings were harvested in Brooklyn from cultivars known to be susceptible to LRN. The cuttings were rooted and grown the next year at Kitchawan, which is in a rural location about 25 miles north of New York City. Whereas

'Lucie Baltet', a pink-flowered lilac, is only moderately injured by air pollution.

the parent shrubs in Brooklyn continued to show the effects of LRN, their vegetatively propagated — hence genetically identical — offspring recovered completely in the new environment. However, when transplanted back to the Garden, they again developed LRN symptoms. In another experiment, single branches of lilac shrubs exposed to city air were enclosed for 2 to 4 months in clear plastic filter chambers, designed to exclude air pollutants. Foliage on the protected branches remained healthier than portions of the same shrub continually exposed to the atmosphere.

Despite the annual recurrence of LRN, after 1968 we noticed a slight yearly decrease in its severity on lilacs at the Garden, and in several arboreta near Philadelphia. During the same time span, data from air-quality monitoring stations located in New York and Philadelphia showed a trend of decreasing levels of ozone and sulfur dioxide, the two air pollutants which probably cause more plant damage than any others. If this correlation is valid, we can expect an increase in LRN severity if current pollutant emission standards are relaxed.

We attempted to identify the pollutants which were injurious by exposing potted lilacs to ozone, sulfur dioxide, or the gases simultaneously, in laboratory growth chambers. Only some of the LRN symptoms could be reproduced with these toxicants. The diversity of LRN symptoms suggests that additional, as yet unidentified, air contaminants are also damaging lilacs in cities. This might be expected when one considers the many types of gaseous and particulate pollutants which are generated in urban areas.

Diversity of Lilacs

The lilac that gardeners are most familiar with is the intensely fragrant common lilac (*Syringa vulgaris*), of which more than 1,000 cultivars have been recorded. This species, which has its origins in the mountains of Eastern Europe, has also been hybridized with other lilacs most notably the early lilac (*S. oblata*), a native of China and Korea. All told there are about 25 true species of lilacs found in the wild in various parts of the world. Rather few of these others are widely grown in gardens, although some have been employed by breeders to create hybrid groups with their own cultivars.

From our observations of LRN a several locations, it became apparent that certain cultivars and species were obviously affected less than others. This suggested a hereditary character or genetic basis for the differences. To determine if there were true resistance to the cause of LRN, the symptoms were rated yearly beginning in 1968, for about 500 lilac cultivars and species in the following locations: Brooklyn Botanic Garden; Arboretum of the Barnes Foundation, Merion Station, Pennsylvania; Arthur Hoy Scott Horticultural Foundation, Swarthmore, Pennsylvania; John J. Tyler Arboretum, Lima, Pennsylvania; Arnold Arboretum, Jamaica Plain, Massachusetts Howard Taylor Memorial Lilac Arbo

The common lilac (*Syringa vulgaris*), **above,** with its intensely fragrant flowers, is the most familiar lilac to gardeners. It and its numerous offspring vary in air-pollution resistance. From it have come numerous cultivars and hybrids. 'Jan Van Tol', **right,** a white lilac, is only moderately injured by air pollution.

retum of Rosedale Gardens, Millbrook, New York.

The magnitude of the resulting data necessitated their transfer to punch cards for computer analyses to determine the statistical significance of apparent correlations among symptoms, location and year. Through the American Horticultural Society's Plant Records Center and the University of Georgia Computer Center, a multivariate analysis of the data enabled us to rate numerically each cultivar and species according to its sensitivity to LRN. We were particularly interested in those selections which occurred at all six study locations.

A final list of cultivars and species was grouped into three categories; least injured, or resistant; moderately injured; and severely injured, or susceptible. The list in the accompanying table includes a few of the more familiar resistant or susceptible lilacs. It is noteworthy that non-*vulgaris* cultivars and interspecific hybrids showed greater resistance to LRN than the *vulgaris* cultivars.

INJURY INDEX

The lowest numerical rating indicates greatest resistance to air pollution injury to foliage. Flowers are single, except where noted. An *asterisk* denotes cultivars of the common lilac (*Syringa vulgaris*). This is a condensed list. Readers seeking air-pollution ratings for additional lilacs may turn to our forthcoming article in the *Journal of the American Society for Horticultural Science.*

Slightly Injured (Resistant)

	Peking lilac (*Syringa pekinensis*). Flowers creamy white, late. A shrub or multi-stemmed tree growing to 12 or 15 feet and similar to the Amur tree lilac.	1.1
	Meyer lilac (*S. meyeri*). Now considered by some botanists as a form of *S. patula*. Flowers lilac-colored.	1.3
x	*hyacinthiflora* 'Lamartine' (*S. oblata* x *vulgaris*). Flowers pinkish. *S. hyacinthiflora* selections are the closest substitutes for *S. vulgaris;* most have fragrant, conspicuous flowers and bloom a few days earlier than the common lilac.	1.4
x	*hyacinthiflora* 'Buffon'. Flowers pinkish.	1.5
	Himalayan lilac (*S. emodii*). Flowers lilac-colored.	1.5
x	*hyacinthiflora* 'Esther Staley'. Magenta.	1.5
*	'Macrostachya'. Flowers pinkish. The most resistant *vulgaris* selection in our tests.	1.6
	velutina 'Excellens'. Flowers lilac-colored. *S. velutina* is now considered part of the *S. patula* complex, which includes the lilac known in the trade as S. "palibiniana".	1.6
x	*hyacinthiflora* 'Montesquieu'. Magenta.	1.6
*	'Montaigne'. Flowers double, pinkish.	1.7
*	'Mrs. W. E. Marshall'. Purple.	1.7
x	*hyacinthiflora* 'Assessippi'. Flowers lilac-colored.	1.7
	Little-leaf lilac (*S. microphylla*). Flowers lilac-colored to pink. Fragrant. Growth habit is spreading; some shrubs are twice as wide as tall. Occasional recurring bloom in autumn.	1.8
*	'President Fallieres'. Flowers double, lilac-colored.	1.8
	Late lilac (*S. villosa*). Pinkish.	1.8

(Continued)

From this investigation, we recommend that growers consider the LRN disorder when choosing lilacs for city or suburban gardens. Some of the lesser known species and hybrids are not yet widely available from nurseries but may be worth the search if they have low numerical ratings in the table. Although not all have the strong scent or very large flower clusters of the common lilac, they have their own interesting traits and should perform better in polluted air. As an aid to sources for the less frequently encountered species, the grower may consult Brooklyn Botanic Garden Handbook No. 63, *1200 Trees and Shrubs—Where to Buy Them.*

In addition, gardeners should know about a group of enthusiastic plantsmen —the International Lilac Society. It is a membership organization which issues a regular bulletin and periodic newsletter, and an annual convention is held. Particulars are available from the Society's secretary, Walter W. Oakes, Box 315, Rumford, Maine 04270.

x	*henryi* 'Lutece' (*josikaea* x *villosa*). Violet, late.	1.8
x	*hyacinthiflora* 'Pocahontas'. Purple.	
*	'A.M. Brand'. Purple.	1.9
	Nodding lilac (*S. reflexa*). Pinkish. Flower clusters small, more-or-less drooping.	1.9

Moderately Injured

*	'Congo'. Magenta.	2.0
	Hungarian lilac (*S. josikaea*). Fragrant, lilac-violet flowers.	2.1
*	'Lucie Baltet'. Pinkish.	2.2
*	'President Grevy'. Blue-flowered.	2.2
	Persian lilac (*S.* x *persica*) (parentage: *S. laciniata* x *vulgaris*). Fragrant, pale lilac blossoms. Lower growing than most of its kin, and the leaves are smaller, too.	2.2
*	'Charles X'. Magenta.	2.3
*	'Primrose'. Flowers yellowish-white.	2.3
	S. velutina. Pale lilac to lilac pink. Now considered part of the *S. patula* complex. Height varies, but usually lower and more compact than *S. vulgaris.*	2.3
*	'Alphonse Lavallee'. Double, lilac-colored flowers.	2.4
*	'Charles Joly'. Double, purple.	2.4
*	'Mme. Florent Stepman'. White-flowered.	2.4
*	'Leon Gambetta'. Double, lilac-colored.	2.5
*	'Ludwig Spaeth'. Purple.	2.5
*	'Marechal Lannes'. Double, bluish.	2.5
*	'Michel Buchner'. Double, lilac-colored	2.5
*	'Jan Van Tol'. White.	2.6
*	'Ellen Willmott'. Double, white.	2.7
*	'Vestale'. White.	2.8
*	'Maurice Barres'. Bluish.	2.9

Severely Injured

*	'Boule Azuree'. Bluish.	3.0
*	'Edith Cavell'. Double, white.	3.0
*	'Katherine Havemeyer'. Double, pinkish.	3.0
*	'Leopold II'. Lilac-colored.	3.0
	'William Robinson'. Double, lilac-colored.	3.0

Cymbidiums summering on a terrace. The large cymbidiums are huge plants and too unwieldly for most indoor situations. However, the miniature cymbidiums can usually be accomodated if strong light is supplied.
George Taloumis

GROWING ORCHIDS UNDER FLUORESCENT LIGHTS

Richard Peterson

From Horticulture, November 1974

Fluorescent light plant culture has already opened up a whole new world to small home and apartment house dwellers in particular, enabling them to enjoy a far greater variety of plants than they ever dreamed possible.

Among the exotic plants capable of being grown by anyone who possesses a thumb even remotely green are orchids. Even those of us who cannot grow a zinnia in the garden now find that with a little reading and intelligent application we can have beautiful cattelya or phalaenopsis orchids on our windowsills or in our livingrooms any time of year.

Kinds of Lights

Many fluorescent light set-ups are available today, ranging from simple, two-tube fixtures suspended from ceiling hooks to elaborate, four-tiered plant carts. Fluorescent light set-ups may also be built at home by buying the relatively inexpensive fixtures and constructing a suitable framework to hold them.

For horticultural purposes fluorescent lights may be divided into three categories: 20-watt, 40-watt and over 40-watt tubes. Most orchids require a minimum of four hours of natural, shaded sunlight to bloom properly. Translated into fluorescent light this is 1200 footcandles a minimum of 12 hours a day.

The 20-watt, two- to four-tube fixtures, approximately 24 inches in length, emit too little light to be used successfully with most orchids. Good vegetative growth may occur but the flowering is reduced or sacrificed. However, used as a supplement to a well-lighted eastern, western or southern window exposure the 20-watt set-up may provide a reasonably good growing environment for many low-light requiring orchids.

The over 40-watt fluorescent tubes (Very High Output, High Intensity Duro-test, among many) provide the most desirable artificial lighting for orchids emitting upwards of 3000 footcandles of light and are sufficient to flower all but the most light-demanding sorts. But, two difficulties exist with these. The tubes are

96 inches long and are usually too large for use in the home unless a basement environment can be provided. In addition such tubes are costly and raise the electric bill considerably. If space and expense are no object, however, excellent set-ups utilizing them may be created.

Thus, the 40-watt fluorescent tubes are the most satisfactory for the majority of home orchid growers. These tubes are 48 inches long and the fixtures normally come in two- or four-tube units. If you plan to grow orchids solely under artificial light with no supplemental natural light, one four-tube fixture or two two-tube fixtures per group of plants (comprising an area approximately 48 inches long by 24 inches wide) provide the minimum light requirements. Fewer than four tubes will not provide the 1200 footcandles required for adequate flowering.

Many types of tubes are now used in fluorescent light orchid culture. Gro-Lux, Wide-Spectrum tubes have become popular either alone or in a 1 to 1 combination with Cool-White tubes. Others, as Daylight, Vita-lite and Naturescent, yield varying components of the natural spectrums. No fool-proof combination can be offered. Work in orchid culture under fluorescent lighting has just begun and each grower must experiment for himself to find the combination that is most successful for his particular orchids. However, the four-tube, 40-watt set-up will prove satisfactory for most beginning collections.

For successful flowering the lights should be positioned from 6 to 12 inches from the tops of the plants. The plants may be raised to this height on a platform on inverted flower pots and lowered as the flower spikes start to grow upwards into the light. In most cases two characteristics of fluorescent lights must be taken into account for flowering orchids however: intensity and efficiency. Fluorescent lights are most intense in the center of the tubes, decreasing towards the ends. Therefore, place the more light-demanding sorts near the center with the leaves just below the tubes and the less light-demanding orchids towards the ends and farther from the tubes. Most fluorescent lights possess an efficient life for horticultural purposes of no more than eight months. Thus, for optimum growth and flowering the tubes should be changed once every eight months or, preferably, twice a year.

Orchids and Humidity

Orchids are traditionally pictured as requiring the humid atmosphere found in steaming, tropical jungles. This is a misconception. Most orchids grow epiphytically in nature on the branches of trees or bushes, and are open to the air and wind. Rain and dew provide the moisture orchids require while breezes quickly dry the plants. Most orchids will thrive with a 50 per cent relative humidity, unfortunately not usually present in our too-dry homes.

A small, home humidifier operating in the orchid area during the fluorescent lighted hours will create a reasonably humid atmosphere without becoming oppressive. Supplementary humidity for small collections can also be achieved by placing plants over a bed of pebbles kept continually wet. However, do not place the plants directly upon the wet pebbles for they will soak up excessive water. Place the pots some 3 to 6 inches above the pebbles (a wooden frame with chicken wire stretched over it is a good support) so air may circulate beneath the pots. A small fan directed across the pebbles or an aquarium heater submerged in the pebbles will cause the evaporation and humid atmosphere satisfactory for most orchids. Occasional mistings of the plants on dry, sunny days (avoid this on gloomy, winter ones) will also aid in creating humidity. However, be careful not to let water lodge in the plants or on the flowers after the lights are out for this creates favorable conditions for fungus troubles.

Orchids like fresh air. So, open a window a crack occasionally in all but the coldest times of the year. On the other hand, avoid cold or hot drafts blowing directly upon the plants. Many indoor fluorescent light orchid growers run a small, oscillating fan 24 hours a day. This keeps the plants gently moving and the air changing for it is very important not to let the air become stagnant.

Potting Tips

The potting and culture of orchids require much more time than this brief article permits. Good results have been achieved, however, with a variety of potting media. For those who may be a bit heavy-handed in their watering, a porous medium is suitable: 1 part coarse, tree-fern fiber to 2 parts medium-grade fir bark, plus a handful of chopped sphagnum moss and perlite. For those who prefer to water less frequently, a relatively non-porous medium may be used: either osmunda fern or fir bark mixed with chopped sphagnum.

Orchids also come in a variety of sizes and in a variety of pots. A good rule of thumb is: the smaller the pot, the more frequent the watering. However, everyone must devise his own watering schedule based upon his own conditions and the plants he is growing. Normally 4 to 6-inch pots need to be watered once a week, with smaller or larger pots watered accordingly.

Fertilizer Needs

Orchids also need to be fertilized under fluorescent lights, although less than under natural sunlight. Numerous orchid fertilizers can be purchased from a horticultural supply house. A general 18-18-18 fertilizer once a month is adequate or alternate feedings of 30-10-10 (emphasizing the nitrogen for vegetative growth) and 10-30-20 (emphasizing the phosphorus for bud initiation) will suffice.

A small orchid collection in the home should not encounter any major disease problems. Nevertheless, stock a fungicide (Benlate or Captan) and a pesticide (Malathion) to be on the safe side but use them with extreme caution.

Kinds to Grow

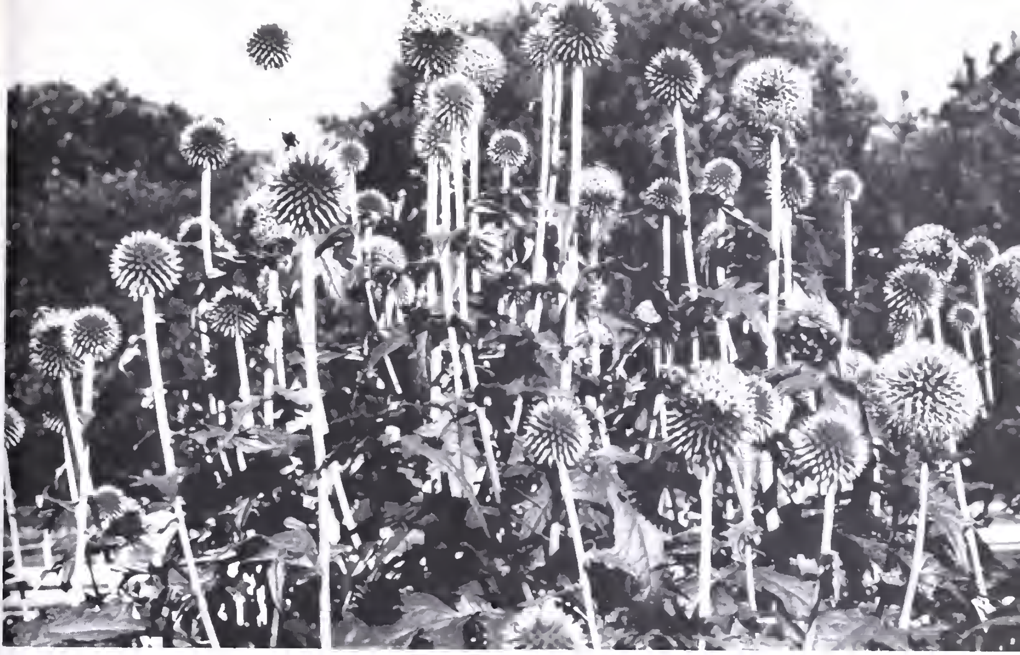
With more than 600 genera of orchids, over 25,000 species and thousands of hybrids fluorescent light orchid growers have an incredible choice of orchids for their collections. A visit to any orchid range or a quick perusal of any colorful commercial catalog will make choices extremely difficult. You will want to grow everything. Certain orchids, however, are more suitable for fluorescent light culture than others.

Orchids which grow in nature under direct sun obviously will be too light-demanding for the average fluorescent lights. Such include the high-light intensity vandas from Asia and the Philippines and their hybrids. Also included are the Asian cymbidiums, so popular as corsage flowers. In addition to needing strong light cymbidiums are huge plants which require cold temperatures to bloom properly.

The medium-light orchids such as the regal cattleyas, dancing lady oncidiums and spidery brassias may be grown under fluorescent lights with good results even though their light requirements lie on the outer limits supplied by most small set-ups. However, low light orchids such as the Asian ladyslippers, *Paphiopedilum*, and the beautiful moth orchids, *Phalaenopsis*, may be grown in any fluorescent light collection.

Interspersed among these general categories are a multitude of species from a wide range of natural habitats and light conditions. A little reading in books obtainable from most large public or university libraries will help to determine whether you can grow a specific species under lights. Many commercial firms are also happy to offer suggestions upon request.

The most important thing to remember about orchid culture under fluorescent lights is this: it is a relatively new field. Understand the principles, experiment with various suggestions—but always remember that you must modify and adjust such rules to your own particular conditions and your own particular orchids.



THE GLOBE-THISTLE

Globe-thistle (*Echinops*), like red salvia and garlic, is one of those things in life which arouse strong passions in people. Either it is liked very much or regarded with a scorn of the sort usually reserved for prunes, colds and higher taxes.

Let's look at the plus side of the ledger. In its finest cultivar, 'Taplow Blue', seen above in the perennial border at the Brooklyn Botanic Garden, globe-thistle has striking steel-blue flowers in ball-like clusters. They are effective for a long time in summer and there may even be a period of bloom recurrence late in the season if the early summer stems are cut back sharply. Excellent in flower arrangements because of their shape and their long-lasting qualities, they may also be successfully airdried in a closet for winter bouquets if cut slightly before their prime.

Globe-thistle grows to about 4 feet tall. The leaves are bristly and thistle-like, and clumps not in flower give a somewhat coarse appearance. Some people get a mild rash when working with the foliage, so a bit of caution or gloves are recommended.

Old clumps are woeful to divide because of a China-deep, stout root system, but this chore can be postponed for years with no adverse effect on the plant.

There are about a hundred species of *Echinops,* though only several seem to have been cultivated in gardens. They are Old World perennials, found in the wild from Spain to Africa and Siberia. In nature their association is with arid fields and rocky outcroppings. In the garden the prescription is for good drainage and sun for a large portion of the day.

Globe-thistle can be grown in all but the very coldest parts of the United States, and 'Taplow Blue' is satisfactory even in southern California, an area where many well-known perennials are not at their best. The word *Echinops* is derived from the Greek, meaning hedgehog-like—an allusion to the prickly nature of the plant. 'Taplow Blue' is available in many garden centers. Mail-order sources include Carroll Gardens, Westminster, Md. 21157; Garden Place, Mentor, Ohio 44060; Lamb Nurseries, E. 101 Sharp Ave., Spokane, Wash. 99202. ⁂

RESCUE FOR WILDFLOWERS

Janet Oliver Gyer

From THE GREEN SCENE, Sept.-Oct. 1974

THE SPRINGS ran clear between steep banks clouded with pink-white mountain-laurel in full bloom in the woods. The area had the serenity of the shrine gardens I have visited in Japan. People had walked there for years. It was a natural park of oak, beech, mountain-laurel, azalea, mosses and the beautiful low wild flowers of acid woodlands—partridge berry trailing-arbutus, lady slipper, pipsissewa.

A sign appeared, followed by great yellow earth movers. The mountain-laurel woods had been sold along with the adjoining meadow where a shopping center was to be constructed. I talked with the real estate agent, landowner, developer's representative, planner-surveyor, and realized that there were many reasons for the land to be used "sometime." But couldn't resources be saved, couldn't some of its wealth of wild plant material be transferred to gardens where is could grow and from which it could be propagated?

On my first visit to a real estate agent I learned that cooperation abounds when a project can be useful to the public and the developer. When I expressed my concern for the mountain-laurel woods, the agent assured me that his profession isn't made up of ogres rushing to destroy the last vestige of our natural heritage. In fact, he would welcome a visit from interested local people at another site he was planning in order to assess the natural plantings and help save the best of the natural landscaping.

I needed to find a group of interested people, so I presented a slide show to the County's nature club. Those interested in the program were invited to a picnic in the woods during mountain-laurel bloom. The owner was not free to join us, so we sent him some of our suggestions for saving at least a portion of the woods. Then our group dispersed for the summer. Word came of the New Jersey ban on open burning set for January, 1973; "sometime" became a rush to clear all the land before the end of the year. The developer had listened to us courteously, but now he told us we should hurry to remove any souvenirs we wanted before the mountain-laurel woods was posted against trespassing. Hastily organized trips did rescue plants, but not enough. One hundred and fifty acres were bulldozed and burned.

From this effort we have some successes. Tiny mountain-laurel seedlings safely lifted to their new homes in their moss nurseries have doubled in growth in one year, and we did not lose a single seedling. It is now time to share them with fellow gardeners as donations to a plant society sale. Moss is now high on my "want list" for rescued material. How happily woods' plants nestle in the smoother mosses, drawing moisture and sustenance from their protector. Even trailing-arbutus cuttings manage to thrive in a moss nursery. Partridge berry fortunately found its way to a group of Girl Scouts building terrariums just before the woods was destroyed in November. And the bits and pieces of partridge berry broken from the larger plants weren't wasted. I placed them in a flat of sand and peat moss covered with a plastic bag "greenhouse" where they obligingly rooted at every node.

Recently, we have had other successes with cuttings of difficult-to-transplant material. Our groups of interested gardeners are branching out from rescuing plants to rescuing endangered species by means of cuttings. Again, we've had a positive response to a positive suggestion. Very often permission will be granted by park or public garden officials or private property owners after a personal visit and assurance that proper cutting and collection methods

The successful rescue of a lady-slipper depends on deep digging of the clump so roots are not disturbed and a goodly amount of existing soil is carried along with the clump to its new position.

Photographs by Carol Bell

are to be used. The result is access to heretofore off-limits materials.

Collecting Seeds

Collecting seeds is fun because it encourages new gardeners to really look at their plants. Sharing seeds with other gardeners makes it possible to insure pockets of bloom in our backyards. What a thrill this year to find the tiny strawberry-like trailing-arbutus seed pods before the ants! We'll be able to share the seeds with gardeners far from the mountain-laurel woods.

In New Jersey the Pine Barrens Conservationists work with road crews to advise them of the best dates for cutting along the roadsides in order to allow full seed production of roadside flowers. A good rescue project for a garden club, or even an individual, would be to chart seed-maturing dates to protect roadside bloom—and to interest the local Highway Commissioner in the project.

Lady Slippers

Now that I am acquainted with a number of groups interested in wildflower rescue, I can plan a trip whenever plants are in danger of destruction. As for the time to move plants, the late Doretta Klaber wrote in *Rock Garden Plants* that she did not transplant in winter or when there was a long dry spell in summer. She found August to November a good transplanting season and assured us that plants can be moved in spring when they are at the height of their powers.

I wish I'd paid attention to her because the lady slippers were in bloom when I first visited the mountain-laurel woods. At that time I thought that the developer's clearing was years away and I could wait until very early the next spring to transplant them. We went back to the woods toward the end of the lady slipper blooming cycle to pollinate them, a project we pursue with our own plants. Agricultural practices and gypsy moth sprays often destroy the bees that pollinate native orchids and it is a fascinating service to help their propagation along. It is a simple matter to pollinate lady slipper orchids; the pollen is the yellow, waxy sac at the slipper opening, one on each side. Take a small stick and transfer the pollen sac from one flower and attach it to the second flower's stigma, which is located just under the lip. In our patch we were not getting many seed pods until we artificially crossed the blossoms. Now four out of five set seed. We went back in the summer to show friends our hidden woodland and found that 10 out of the 15 plants in one patch had set seed.

The mountain-laurel woods taught me that advance planning is the key to successful wildflower rescue. There is no

Edgar T. Wherry (Professor Emeritus of Botany, University of Pennsylvania) inspects plants on rescue mission in New Jersey.

point in hand-wringing after the construction project is approved by the Planning Board and others at the community level. I keep in touch with builders. At a recent Planning Board meeting a developer was beset by many problems. My suggestion that our group enter the property to save wildflowers before construction resulted in his inviting us to remove plants.

After we received permission for the rescue trip, a scouting party composed of several of our more knowledgeable members visited the woodland to prepare a list of plants that could be rescued. This was circulated to the gardeners so that they could have their planting sites prepared before digging. We reminded them that native plant material will do best when its garden habitat duplicates its natural one. Habitat requirements are set forth in several books which I took along to the rescue trip. My favorite is by Edgar T. Wherry, *Wildflower Guide,* a Doubleday Nature Guide. Dr. Wherry has long championed the idea of wildflower rescue in areas subject to destruction, but he urges gardeners to provide conditions for the plants to reproduce (possibly under a gardener's help) by seeds, runners, offsets. Only in this way is a plant saved, because there is bound to be some loss in the transfer of a plant from one site to another. A good help for me in analyzing pH and other requirements is *Growing Woodland Plants* by Clarence and Eleanor G. Birdseye, a Dover reprint.

Digging Demonstrations

Before digging begins, the group is shown how to dig a large sod, and how to transfer a sod to a piece of plywood or large tub, with a good supply of the woods' soil. A demonstration plant was dug so root structure could be observed closely. Seeing how deep and how far the roots traveled seemed to affect the care the rescuers took in their chore. And it is a chore. Until you have hauled a heavy plant through rough woodland you don't realize how simple it is to just buy a plant. Most wild plants are accustomed to the accumulated woods' duff, which provides for them the best compost of all. But excellent compost can be made from common garden waste. The neatly bagged leaves and grass clippings on every suburban street left for disposal trucks would make excellent compost for native plants.

Suggestions for Rescue Missions

- Obtain permission from the appropriate authority (state, municipality, landowner, builder).
- Work with environmentalists, nature club, garden club, scout, school, or church group.
- Set a definite date for a wildflower rescue trip. Explain that bootleg trips could endanger the project.
- Avoid large-scale publicity; it draws too many people.
- Prepare a handout covering plant material to be obtained and suggestions for maintaining it, including the importance of watering.
- Advise participants to bring equipment such as: shovel, axe, pruning shears, plywood (to put under plants when carrying), burlap (to wrap roots), plastic bags for small plants, cooler and ice to protect small plants from car heat, leaf bags for large plants and to hold soil to reproduce habitat in new area. ☘

The idea of kudzu taking over and wiping out southern forests isn't as far-fetched as it sounds

THE VINE THAT ATE THE SOUTH

Joel Blackwell

From GEORGIA, November 1973

PERHAPS somewhere around the year 9595, if you like the popular doomsday song, the last man to leave earth on his space ship will slowly take a last look at humanity's first home. We can't be sure what he will see: an endless vista of junk cars, or a sea of pasteboard boxes, tin cans and non-returnable bottles? Perhaps the last man off earth will be unable to see much at all, because of air pollution.

But one thing we know: whatever he sees, it will not be visible long. It will soon be covered with kudzu. Because if you leave kudzu alone, sooner or later, it covers everything. Of course, everybody who grew up in the South knows what kudzu is—the creeping, grasping vine you see along the highway, laying a plush green carpet of hand-sized leaves across the gulleys and up into the trees. It is highly visible, and tourists call the state agriculture department in Atlanta, asking how to transplant this interesting vine. The tourists are politely told to take home a rattlesnake instead—they'll be better off.

And they will, because the friendly kudzu-vine, once a charming producer of sweet-smelling blossoms and shade for porches before the advent of air conditioning, is now gradually chewing away at the edges of our forests, patiently killing them, sprout by sprout, bush by bush, and tree by tree. In leaps and bounds, it climbs over all plants in its path, smothering out the sun, and life itself. Scattered in thick patches all over the south, kudzu sits simmering like a cancer in the body of our forests—undiagnosed, untreated, but slowly growing.

Channing Cope, the great agricultural writer for the Atlanta *Constitution* and one of kudzu's most ardent supporters, estimated that under optimum conditions, one acre of kudzu in 100 years could spread to more than 13,000 acres.

The first person who made the mistake of letting his name get on record in support of kudzu (*Pueraria lobata*) was a farmer, C. E. Pleas, in Chipley, Florida. It is not recorded where he got them, but in 1902 he had three kudzu plants, and was trying to grow them over his summer house for shade. The vines would not grow fast enough to suit him, so two years later, he pulled them up, and replanted them by a trash pile behind his house.

The plants survived. In two years, they spread over a huge area, covering the trash pile, and considerably improving its appearance. The ability to cover trash, as important as that may seem, did not lead to the spread of kudzu all over the South. It came about because Pleas noticed that his chickens would eat all the kudzu leaves they could reach. Seeing that, he tried cows on it and they liked it, too.

That was all it took. By 1909 Pleas had 20 acres of kudzu growing, and the word began to spread. Pleas is generally given the credit, or blame, for discovering kudzu.

Pleas gave it to E. B. Epps, father of the writer Susan Epps, and he gave it to Paul Tabor, who brought it to Georgia. Tabor, just out of the University of Georgia and working with the extension service, thought kudzu was just what the Georgia farmers needed to pull out of a bad depression. He was just one of many who became an instant convert.

About 1920 Tabor handed the green

tiger's tail to John Rigdon, the late city councilman of Columbus and a pioneer conservationist. At the time, Rigdon was working for the Central of Georgia Railroad as an agricultural agent. When he saw how fast kudzu grew, he had it tested, and found it had about the same nutritional value as the most popular feed at the time, alfalfa. It also sent roots down into the soil 5 to 7 feet, and took nitrogen from the air and put it in the ground.

The discovery set Rigdon on fire. His job was to get Georgia farmers to grow something besides cotton, so the railroads would have freight to haul year round. He was also trying to find something that would replenish the exhausted soil and keep it from washing away—which it was doing very rapidly.

Kudzu was the answer to his dreams, and Rigdon soon became a familiar sight, bouncing around the backroads with a carload of kudzu plants, trying to get everybody to grow them. Through Rigdon, the railroads provided free plants and advice, and thus started a vast program of growing kudzu for animal feed.

Channing Cope is widely identified as the father of kudzu, because he constantly wrote about it in the *Constitution* and broadcast its virtues on his farm radio program. He may get more blame for spreading kudzu than he deserves. About all Cope was guilty of was joining a stampede. By the time he started pushing kudzu, in the late 30s, it was the rage in agricultural circles. Cope capitalized on the fad by forming a Kudzu Club in 1943. He soon had 20,000 card-carrying zealots, gleefully spreading the kudzu gospel, eagerly planting it in every nook and cranny. No religious movement is complete without a bible, and by 1949, Cope had finished writing one. He named the new religion "Front Porch Farming" and the bible was published under the same name.

"Front porch farming" was an amazingly simple, devilishly appealing theory. The idea was to have some green plants growing somewhere on your farm all year round. All you had to do was nudge the cattle from one field to the next, as the seasons changed. A lot of kudzu was planted after farmers read Cope's book and thought they had found an easy way to make a living.

Oddly enough, about the time Cope's book was published, the Soil Conservation Service dropped its kudzu programs in favor of other plants. Through the 50s, kudzu lost popularity as a crop to the point where hardly anybody cultivates it now.

Kudzu does have many potential uses, although not enough to outweigh the damage it does. The Japanese used to make a grass cloth out of the vine fibers, and in hard times, they extracted a starch from the roots for pastry-making. You can eat kudzu, just like the cows and chickens do, and you will find it is very nutritious. It's not even bad tasting, if you boil it long enough, falling somewhere between cabbage and collards.

There are only two things wrong with kudzu—it kills trees, and nobody knows a practical way to stop it. You can poison it, but it costs too much, and it takes three years. Besides that, the poison kills everything else, and the government is gradually banning the ones that work.

A much simpler way to get rid of kudzu is simply to allow cattle to overgraze it. There's only one problem. Cows do not climb trees, where the kudzu-vine does its most pernicious work.

Nobody knows a cheap, effective, safe way to control kudzu. And furthermore nobody is even looking for one anymore For the most part, all those acres and acres of kudzu are not wreaking enough economic damage to get anyone upset so they are just left alone—slowly growing, creeping, expanding.

Tabor, one of the most important link in the chain that spread kudzu, is in his 80s now, living in Athens after retirement from the SCS. Looking back on the kudzu crusade, he admits it probably was a bad mistake. But at the time, he says "We just didn't realize it. The spreadin of it was underestimated."

The venus flytrap (*Dionaea muscipula*) is one of the most readily identified insectivorous plants. The traps that close over insects are expanded ends of the leaves.

Photographs by Herbert Newlin

INSECTIVOROUS PLANTS AND TERRARIUMS

Stephen K-M. Tim

FADS come and go in horticulture. However, the interest in plants that "eat" insects has been continual ever since they were first found in the wild and described in books. In times past, when plants were discussed in somewhat more romantic ways than they are today, imaginations frequently ran riot. There were even horrendous tales of man-eating plants.

Although we hasten to assure younger readers, particularly, that the man-eaters do not exist, insectivorous plants are still fascinating! And what better way is there to become acquainted with them than by growing a selection in the home? If you haven't had any experience with these plants, here is an introduction to some of the most easily grown kinds and their care. There are other insectivorous plants that may require more specialized cultural conditions, but getting to know the basic needs of the common ones is a vital initial step.

First, consider some of the biological factors that endow these plants with such unique characteristics. In nature, insectivorous plants grow in bogs and certain other wetlands where soil conditions are usually very acidic. The various elements associated with good growth are not found in a form readily available to the plants. Although such plants do contain chlorophyll, these elements—among them nitrogen, phosphorous and potassium—are necessary for photosynthesis to occur. A great part of these elements is probably derived from the breakdown of animal tissue, primarily the proteins. "Plants that eat insects," a phrase often used to describe these wonders of nature, really conveys the wrong impression; plants do not, in the British expression, "up, and gobble down their grub." However, the comparisons with human traits that accompany insectivorous plant descriptions are difficult to overcome.

(Continued)

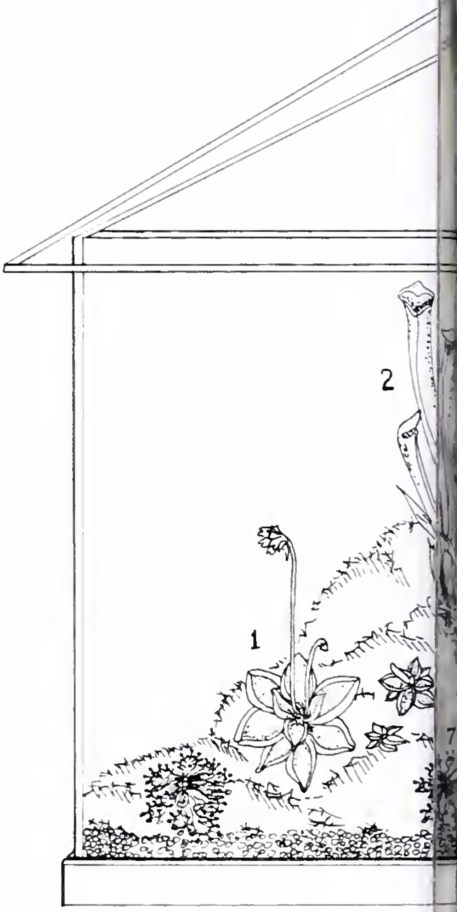
In the Home

Try to simulate the conditions found in bogs by providing a suitable growing medium. It is essential to maintain high humidity with good lighting. For this, a terrarium, an "insect terrarium" in fact, is excellent. Don't raise these plants in the tiny plastic cases in which they sometimes come pre-packed from the store; they will likely die because such cases are very subject to extremes of temperature. Even a short bout of sunlight can prove detrimental to plants grown in them.

If you start with a collection of, say, six or eight plants, the most suitable container is a fish tank, approximately 12 inches by 18 by 12. Line the base with an inch-deep layer of clean, coarse bird gravel (1/8-inch grit size or larger). On top of this add:

3 parts *coarse* (unmilled) sphagnum moss. This is usually sold dried. If the moss has been only recently dried, it may green up again. If not, incorporate some live sphagnum (obtainable from insectivorous plant dealers or, occasionally, florists, or you may know of a bog where sphagnum grows naturally) and the new sprouts will spread over the whole growing surface.
1½ parts coarse perlite
1 part builder's sand (optional)

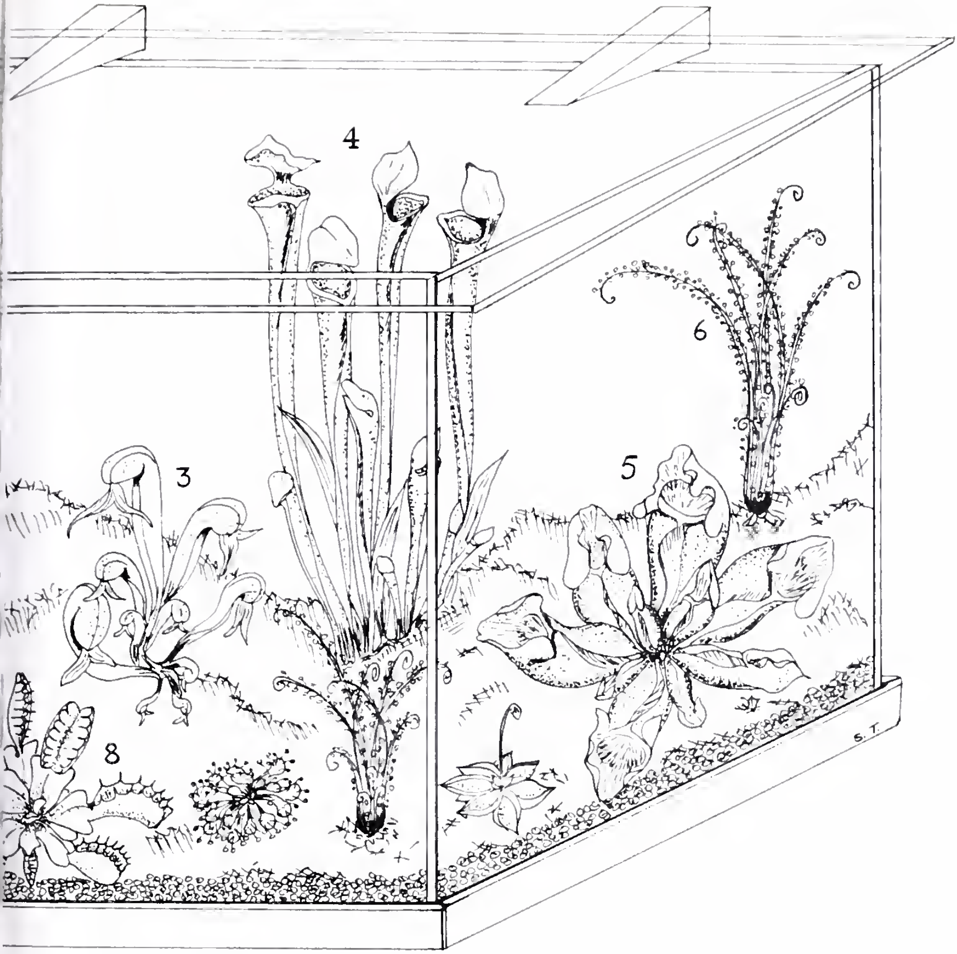
If the sphagnum is bone dry, soak it in a bucket until thoroughly wet. Mix the ingredients well. Plants may be grown directly in the medium or first planted in pots (plastic or clay) and, in turn, submerged in the medium. The latter method is preferable because the individual plants can be tended more easily and rearranged when desired. Whatever the case, the medium should also be contoured interestingly over the bird gravel with high areas (4 inches or so) toward the rear and lower ones (about 1½ inches) toward the front. A series of artistically placed hummocks provides a pleasing landscape—or bogscape.



Plants for Terrariums

Pitcher Plants *Sarracenia minor, S. psi tacina, S. rubra, S. flava* and *S. purpure*

The pitcher-like leaves forming th traps are open at the top and are fille with water. Insects, lured by the nectarie on the sides and mouth of the pitche find their way into the pitcher and the escape is hindered by downwardly poin ing hairs, especially around the mout of the trap. Digestion is carried out b the action of digestive juices (enzymes secreted by glands on the inside of th pitchers. Bacteria are also present in th water and aid in the breakdown of th insect. In this way, valuable nutrients ar



PLANTED TERRARIUM OF
INSECTIVOROUS PLANTS

1 Butterwort (*Pinguicula caudata*)
2 Miniature Huntsman's Horn (*Sarracenia rubra*)
3 Cobra-lily (*Darlingtonia californica*)
4 Huntsman's Horn (*Sarracenia flava*)
5 Northern Pitcher Plant (*Sarracenia purpurea*)
6 Threadleaf Sundew (*Drosera filiformis*)
7 Sundew (*Drosera rotundifolia*)
8 Venus Flytrap (*Dionaea muscipula*)

Drawing by the author

Butterwort (*Pinguicula caudata*)

Miniature Huntsman's Horn
(*Sarracenia rubra*)

made available for absorption by the plant.

Venus Flytrap *Dionaea muscipula*

This is the one plant that manages to capture the imagination of most young people when they are first introduced to it, usually in some children's encyclopedia. It is touching to see a child's face light up when he or she beholds the living flytrap for the first time; here is one of those few plants that is unfailingly recognizable from drawings. The traps consist of the expanded ends of the leaves, hinged down the center and with long, teeth-like projections on the edges. An insect, setting off the trigger hairs on the insides of the leaves, causes the two halves to snap shut over itself. Juices are produced from the leaf and serve to digest the soft parts of the insect. The more resistant parts remain untouched and are present on the traps when these open again after about ten days, ready for the next meal.

Sundews *Drosera rotundifolia, D. intermedia, D. filiformis*

These are like jewels when the beads of viscid substance on the leaf tentacles glint and sparkle in the light. The sticky substance on the tentacles prevents the escape of the tiny prey (an ant, for example) and the more the prey struggles, the more it becomes enmeshed among the tentacles. These gradually bend over and touch the insect and the leaf itself may curve over to envelope it further. If live sphagnum is used, the moss must be trimmed occasionally to prevent it from surrounding and smothering the delicate sundews.

Butterworts *Pinguicula pumila, P. lutea, P. vulgaris*

The neat rosette-like formation of bright green leaves make these very attractive plants. Their flowers are also most inviting, and well-grown specimens seem more suitably placed among the alpine rock plants than in a humid terrarium. The leaves are covered in minute glands that secrete a sticky fluid. Very tiny insects fall prey here and the edges of the leaves may respond by partially curling over them.

Cobra-lily *Darlingtonia californica*

Although this plant grows out of character in the terrarium, it is nevertheless most interesting and loses none of its cobra-like appearance. In the wild it may reach a height of 2-3 feet but grown in the terrarium, a number of factors, one of which is the relatively high temperature, result in this plant remaining dwarf. The traps here consist of hollow, pitcher-shaped leaves, the mouth of which is hooded.

Care

All of the plants cited above are adaptable to pot culture. Pot them individually in the sphagnum mixture and sink the pots in the terrarium. As mentioned previously, a few sprigs of live sphagnum tucked in here and there will soon flourish and carpet the whole surface with lush green growth.

Water with a spray bottle but don't let too much settle in the layer of drainage gravel. One refinement here is to have a drainage hole at the base of the terrarium, thus making it possible to flush out the medium with fresh water every couple of months. Such an opening should be covered with fine aluminum mesh to prevent any of the mixture from being washed out. In the event of the local tap water being very hard, use distilled or rain water, but in general, tap water is quite suitable. A sheet of plexiglass over the top will help maintain the high humidity within the terrarium. However, keep it slightly ajar during the warmest part of the day.

Good lighting is essential but avoid prolonged direct sunlight striking the terrarium, as this will cause a rapid heat build-up and may damage the plants. A bright east or west window is fine but a spot a few feet away from a southern exposure is ideal. Many forms of the Venus flytrap show a reddening of the inner part of the trap with good light intensity. In fact, some forms take on a rich red coloration. These effects may be used as indicators of whether or not the light is bright enough. Some hobbyists have resorted to supplementing the available light with fluorescent tubes with great success.

A day-time temperature of around 70° to 75° F. is ideal. The average room is sometimes warmer than this but it is important that evening temperatures do go down to about 70° or less. The plants mentioned here benefit from a cool rest period during the winter and, if at all possible, should be moved to a cooler location, such as an unheated sunporch, from mid-December to about the end of February. Try to keep temperatures at 60° or less during this time.

Do not apply fertilizer to the growing medium. However, by all means "feed" the plants the occasional morsel of food. Flies often find their way into the terrarium and provide a useful tid-bit for the pitcher plants and flytrap. Otherwise, use tiny pellets of lean beef. Whatever the case, do not overfeed. This leads to decay of the traps and even the whole plant. Also, constant "teasing" of the flytraps is not a good practice.

Sources for More Information and Plants

Insectivorous plants have had a wave of popularity recently, and there is even a quarterly publication devoted to them. It is called the "Carnivorous Plant Newsletter." Particulars are available from either of the co-editors: D. E. Schnell, Rte. 4, Box 275B, Statesville, North Carolina 28677; or J. A. Mazrimas, 329 Helen Way, Livermore, California 94550. Readers should also know about a new group, the Terrarium Association, which issues a newsletter, too. For further information write to its editor, R. C. Baur, 57 Wolfpit Ave., Norwalk, Connecticut 06851.

Insectivorous plants are available from an increasing number of dealers locally. However, if you have difficulty obtaining them in your town, send a stamped, self-addressed, business-sized envelope to Insectivorous Plant Department, Brooklyn Botanic Garden, Brooklyn, New York 11225, and you will receive a list of mail-order sources by return mail.

A final word—a plea perhaps. Please, please do not over-collect plants in the wild. They are there for all to enjoy—and marvel at. ❧

LUNCH-HOUR GARDENS RELIEVE OFFICE TENSIONS

Joan Marks

From The New York Times, July 7, 1974

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Employee gardens are sprouting all over the country as a growing number of corporations make land available for staff use. Many lunch-hour gardeners wield the hoe to counteract staggering increases in the cost of food. Others see it as a new challenge, a form of exercise, or a chance to relax away from office tensions.

From management's vantage point, the land was sitting there idle anyway. Now it is being used constructively. The cost to the employer is negligible, since maintenance crews can get the soil ready for planting in a few days.

For this minimal investment, corporate spokesmen acknowledge they are reaping a substantial harvest in the form of improved esprit de corps among employees. The roster of companies who provide growing space for their employees is as varied as the types of people who garden at work.

- The RCA David Sarnoff Research Center in Princeton, N. J., has 230 plots measuring 20 by 25 feet for 300 employees to share. Now in its second year, land is made available free of charge and the community gardening project has doubled in size. One factor contributing to its success, say spokesmen, is the underground plastic pipes installed to carry water to the site. Spigots connected to the pipes supply each section's needs.

- Rodale Press, of Emmaus, Pa., a publisher of magazines and books on organic gardening, health and environment, also is in its second season of providing garden space for employees. There is a $10 annual rental fee for each 15- by 45-foot plot, and only organic growing methods may be used. About two dozen people participate.

- An old timer in the community garden field, the Dow Chemical Co. of Midland, Mich., has had an employee garden for 34 years. For a $7 annual service charge per plot, the firm plows, fertilizes, rakes and stakes the land. At present, 200 plots measuring 40 by 50 feet are farmed.

- Another veteran, Lederle Laboratories Division of American Cyanamid Co., of Pearl River, N. Y., has been offering gardening space to its 3,500 employees for the past 25 years. The company sponsors its own garden club, an offshoot of the Lederle Employees Recreation Association, which also nurtures such hobbies as chess, bowling and soft ball. Some of the 45 Lederle farmers are so pleased about it that they've asked for —and received—more than one 30- by 40-foot plot. Most of the crops are those commonly found on truck farms, with an occasional sprinkling of more exotic fare such as leeks and shallots. One employee of Indian extraction reports a smashing success with Indian peppers. Every fall, there is a garden club show with trophies and blue ribbons for the biggest squash and juiciest tomatoes.

The academic communities are joining the trend.

- At Rutgers University in Piscataway Township, N. J., married students and their families are farming 50 plots under the supervision of Dr. William Drinkwater, professor of vegetable crops at the university's Cook College.

- For this first time this year, 250 plots have been marked out on school property by Princeton University for use by administrators, faculty and staff. The school offered participants a free three-night course this spring, and almost every-

The New York Times—Gene Maggio

Gardening space has been available for the last 25 years to employees of the Lederle Laboratories, a division of American Cyanamid Co. in Pearl River, New York.

one enrolled. Some 265 people tend the 20- by 25-foot plots.

A newcomer to the corporate lunch-hour gardens is the international headquarters of Ingersoll Rand, in Woodcliff Lake, N. J.

Says Wynn Moseley, a company spokesman, "Only about six people expressed interest at first, but now we have 53 gardeners. Our chairman, William L. Wearly, grew up on a farm in Indiana, and he encouraged the idea."

Mr. Moseley concedes that getting the project started has been a rough—and rocky—row to hoe.

"We're learning as we go along," he reported. "Next year, for instance, we plan to deep plough. This time we just used a bulldozer and disced the soil. Too many rocks remain." The rock problem is the chief thorn in the side of a three-man committee created to run the project.

Marty Mulholland, a committee member and assistant comptroller for the financial corporation, says, "One woman complained and complained to me about the rocks. I suggested she use some of them to mark off the area she was tending. The next time I saw her, she was still complaining. She had run out of rocks!"

Less sophisticated than some installations, Ingersoll Rand farm land is located next to a pond. The company built a dock so that employes can fill watering cans and pails from the available source of water.

On a recent sweltering lunch hour, Robert Hartje, who is with the company's tax department, was out in shirt-sleeves and tie watering his peppers, tomatoes, beans and lettuce. He also is growing zinnias, marigolds and asters.

"This is a real bonanza for me," he asserted. "I live in Martinsville on the first ridge of the Watchung mountains, and there is no sun at all. I just can't have a vegetable garden at home."

Dressed in a white uniform, company nurse Carol Tiscia was on her way back to work after inspecting the crops. She is achieving what she terms moderate success with tomatoes, chives and zucchini. "I used to have a house, but now I live in an apartment, and I really missed getting down to the earth," she observed.

Maggie Green, a maid to the executives, hopes to reap enough vegetables to can this year without having to buy any. "Last year, I spent about $45 for vegetables to can," she reported. "This spring, I spent $13 on plants and seeds."

At least one company wife has turned out to be the family gardener on corporate property. Sarah Sedgwick, of Woodcliff Lake, was visiting with 7-year-old Adam to check on how the crops were faring after some deep watering on the previous day. Her husband, Paul, is manager of planning and administration.

"He does the brain work and I do all the brawn work," she said. "Yesterday, I carried 15 diaper pails of water to the garden, and today I feel like someone's stabbed me in the back!" Mrs. Sedgwick grew up in the rural south and is an old hand at gardening. She uses a mulch of newspaper covered with grass clippings to protect squash.

Mrs. Sedgwick expects to overcome the difficulties of launching a new garden with regular visits during the week supplemented by some help from other members of the family on weekends. "A lot of the wives really didn't know each other well before we started gardening," she said. "On weekends, it turns out to be a social outing as well as a productive way to spend time." ☙

SAN FRANCISCO GARDENS OF COMPOST FROM CITY GARBAGE

By United Press International

Vacant city lots in San Francisco are being turned into small vegetable farms in a project designed not only to fight inflation but to cut down the mountains of garbage dumped every day.

The city provides the land, seed, tools, water and compost, said Brian Fewer of the Landscaping Division of the San Francisco Department of Public Works. All the citizen has to do is come up with the time and muscle. Fewer said the program, started in 1973, has grown to 27 gardens with six more in the planning stages.

The gardens, which cover a total of about 12 acres, are tended by persons of all ages, from school children to senior citizens. One, in the south of Market area, is farmed mainly by elderly Chinese who wear coolie hats and carry jars of water suspended from sticks on their shoulders. "Some of the gardens are ornamental with beautiful flowers but most by far are used for growing vegetables, although we also supplied 100 fruit trees," Fewer said.

The city started the program as a pilot project to determine uses for the solid wastes that are carted to the dumps each day. "We use just about everything for the compost," Fewer said. "Sludge from sewage, sawdust, brush clippings, coffee grounds and even spoiled cucumbers." About 2,000 cubic yards of compost have been used so far on the gardens. That is hardly significant compared to the tons taken to the city dumps.

Fewer is quick to add that this is a pilot project with only a $17,000 budget, but it has shown that people do have an interest in gardening.

Some cities have one or two small plots but that is about it. "It would be good for all cities to take a look at what we are doing here because solid waste is a problem in every urban area."

—*J. O. Clifford*

Woven wood fences are good-neighbor enclosures, since both sides are alike. Less expensive enclosures may be made of wire and evergreen vines.
Photographs by Molly Adams

CITY GARDENING

Nelva M. Weber

From Horticulture, June 1974

In spite of inherent limitations, it is possible to have presentable, even attractive, gardens in the largest and most overcrowded of our cities. These gardens can range in size and location from window boxes, potted plants on a tiny balcony, roof gardens surrounding a penthouse, a sliver of ground-level space enclosed by skyscrapers, to a temporary garden on land waiting a construction crew. Obviously, the limitations vary depending upon the location, but the universal problem is air pollution. Other problems include inadequate space, lack of sunlight, excessive wind, minimal air circulation, poor drainage and infertile or inadequate amounts of soil.

The easiest backyard gardens are those open spots in the less densely populated urban areas which somewhat resemble a suburban environment. Many plants succeed here and the problems are minimal. The same space sandwiched between tall apartment buildings is naturally less rewarding. There may be little sun most of the day or it may be concentrated in a small area which becomes excessively hot in summer. The air circulation may be poor and there may be little soil with bed rock or building rubble beneath. Even there the situation is by no means hopeless.

Successful gardens in both city and country settings begin with a careful design or organization of space. All gardens not only have length and width but also height. This third dimension is easily visualized in a city setting. A city garden is often viewed from several vantage points. When one looks out upon it from the same level the enclosure is an important part of the picture with a few specimen plants of varying heights to add interest and give scale and, perhaps, a tree for a canopy overhead. In a garden which is viewed from above the pattern or arrangement of the floor space is doubly important. Looking down onto a tree top adds a note of concealment and gives a feeling of third dimension.

Since city gardens are likely to be small, an impression of open, uncluttered space is important. The simplest garden might well consist of a fence or wall, interrupted by an occasional vine or espaliered shrub, enclosing an open space, usually paved and surrounded by or interlaced with open space carpeted with a ground cover. Single specimens or plant groups may be added as needed for height or silhouette, while a tree provides an overhead pattern or hides an unattractive view.

In a city garden an enclosure is needed for privacy, but it is also important as decoration. Brick walls are good enclosures and pierced brick panels allow increased air circulation.

Many city sites are more closely akin to Mediterranean courtyard gardens than to those of nearby suburbia. Some situations permit a terrace adjacent to the house with easy physical and visual access via sliding glass doors. There may also be room for a second terrace at the opposite end of the garden, and a change of grade gives an opportunity to use one or more steps for added interest. Circulation or a way of getting about is necessary, and the walks become design elements as well as practical features. Brick, flagstone and washed gravel with a raised curb are satisfactory materials for terrace and walk construction.

Some city gardens are used while others are mostly to look at. In high pollution areas the particulate fallout is enough to discourage extensive eating and drinking in the garden unless an awning is provided. Even though sitting out is only an occasional activity, paved areas and walkways are important features, since they are a means of visual projection and also provide a nucleus around which ground covers and other plants can be arranged.

The easiest lack in city gardens to correct is the soil. For example, it is even possible to have a garden of paving material decorated with plants in containers of adequate soil. Poorly drained areas and gardens of shallow, inadequate soil can be transformed by using raised planting beds. One city garden with which the author is familiar is underlain with bedrock. These rocky beds received a base of coarse gravel which was covered with a layer of fiberglass insulation laid with lapped joints to prevent the topsoil above from washing down into the gravel. The beds were then filled with good soil and planted with English ivy. Where taller plants were needed square flue liners or sections of round sewer pipe in varying sizes and groupings were set on top of the soil, filled with the soil mix and planted with shrubs, broadleaved evergreens and small flowering trees.

Since city gardens need frequent watering, there is considerable leaching of fertilizers. Also the limy materials may leach and a very acid condition result. So, lime is usually required. Thus, most of the soil in city gardens can be improved by the addition of organic matter, fertilizer and lime. Yet, even without these amenities the ubiquitous ailanthus adds a Rousseau-like touch to the city garden. No tree can match its tolerance of the poorest of urban environments.

Where growing conditions are somewhat better, the northern red and willow oaks may be substituted if light and soil are available. *Sophora japonica* and *Koelreuteria paniculata* are somewhat smaller trees which tolerate city conditions, flower in summer and tend to create an exotic tropical effect. The Callery pear, flowering crabapples, saucer magnolia, Japanese tree lilac, flowering cherries and the hawthorns are all good, small, flowering trees for city use while sunny walls may be espaliered with firethorns, rose-of-Sharon or forsythias trained in fan shapes. Wisteria will cover a sunny arbor and a fig tree in a protected, sunny corner will add an accent of tropical texture.

A feature of interest is always a welcome addition to the city garden. Naturally, it should be in scale with the garden and sympathetic with its general mood: a bit of statuary, a splash of color, some form of moving or standing water. In this garden, the main feature is the wall fountain with its gentle fall of water to the basin below that is surrounded by flowering geraniums.

For a rich effect shaded city gardens can specialize in broad-leaved evergreens. English holly does surprisingly well and rhododendrons tolerate fairly deep shade. Pieris, Japanese holly, inkberry, Oregon holly-grape, leucothoe and the evergreen euonymus are all good for city gardens but, obviously, flower better if they receive partial sun. English ivy is the best city ground cover although pachysandra s also useful and vinca tolerates more un than the other two. Mild climates can use dwarf bamboo (*Arundinaria japonica*) as a space filler as well as the gold-dust plant (*Aucuba*) which will grow in dense shade.

Deciduous shrubs with considerable shade tolerance include black haw, *Viburnum prunifolium*, and its cousin, *V. sieboldii*. The hydrangeas do well, especially *H. quercifolia* and *macrophylla*, which usually has blue flowers due to the acid soils. Many needle-leaved evergreens fare badly under city conditions. However, the Pfitzer juniper is tough and can be used in a sunny spot. The elegant white fir, *Abies concolor*, is another possibility and gardens with better than average growing conditions might try Carolina hemlock and Douglas-firs. ⁂

FACTS ON HYDROPONIC GARDENING

Walter H. Phillips

From THE AMERICAN HORTICULTURIST, Winter 1974

HYDROPONIC GARDENING is not what many people think it is. It is not growing plants in water; they are grown in gravel or crushed stone, or other inert supporting medium, over which water containing the plant nutrients flows.

Hydroponic gardening may be conducted on a large scale or on a small scale. Under the conventional method one or more beds are constructed which are filled with gravel or crushed stone. There is a tank containing water into which soluble plant fertilizer has been added, which is called the nutrient solution. This solution is allowed to flow by gravity onto the bed containing the plants, then it is pumped back into the tank. Water and nutrients are added from time to time as needed. This is a "closed" system.

Hydroponic gardening seems to be the most practical method of growing vegetables in the Virgin Islands. For the past fifteen years we have been experimenting at the Water Isle Botanical garden with hydroponic growing of vegetables and have developed a method which is easy and much less expensive than the conventional method. Our new technique produces excellent results under the conditions prevailing in the Virgin Islands.

With our method the bed in which the plants are to be grown is filled with crushed stone to a depth of 6 to 8 inches. Plants are planted in this crushed stone and fed the nutrient solution once a week and are watered each day when it does not rain. As all liquids drain away, this is an "open" system. This system is very easy to operate and produces large quantities of delicious and nutritious vegetables.

A number of questions are usually asked, as follows:

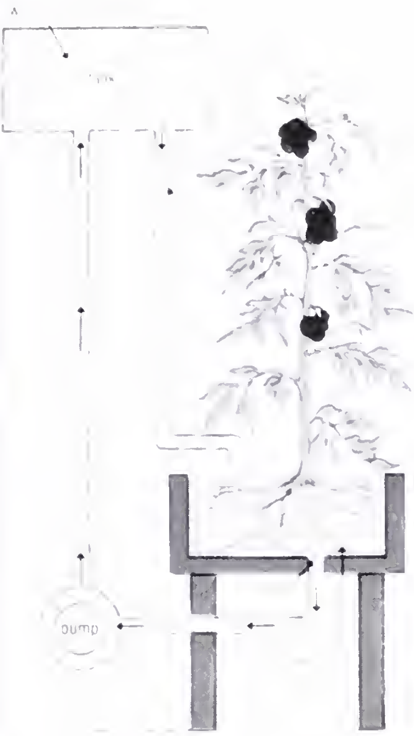
1. How big should a hydroponic garden be? It can be of any size—large or very small. It can consist of one or more pots. It can be a bed 4 feet by 8 feet or any desired size of wood or concrete. It must be deep enough to hold from 6 to 8 inche of crushed stone or gravel. It must als contain a drainage hole or holes in th bottom so that the excess water can ru off and not stand on the plants, as thi would kill them.

2. What medium is suitable for growing? Any inert material will do. As it i difficult to find gravel in the Virgi Islands, the most practical material crushed stone (blue bit or other har stone) in the smallest size available. Dev con (Zinke-Smith) has this at their quarr in sizes of three-eighths inch and smalle which is very satisfactory, and can b purchased in small or large amounts. available, a small amount of perlite ma be added as a topping, and this can usually be obtained locally. Gravel also ma be used but it must not contain any cora as this has too much calcium which affec unfavorably the action of the nutrient solution.

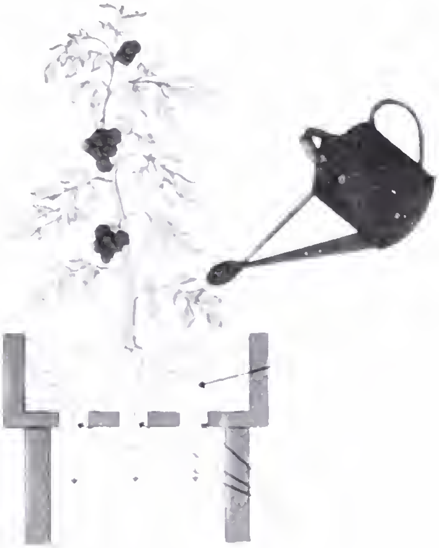
3. What can be grown? Any plants ca be grown hydroponically which can b grown in soil. We have had the best su cess with tomatoes, lettuce, peppers, bro coli, curly endive, and eggplants. Squas cucumbers, pumpkins, papaya, corn ar in fact anything else may be grown, b many of these will require more space.

4. How should the seeds be starte The seeds should be started in a seed be which contains peat or rich earth. Wh of sufficient size, seedlings are transplan ed into the hydroponic garden. If desir they can be first transplanted into sma pots until they reach larger size. It do no harm if some of the soil clings to th roots when planting in the crushed ston

5. What is meant by the nutrient sol tion? This is water which contains solub nutrients; plants must be fertilized make them grow. The solution must co tain a soluble balanced fertilizer, that a proportionate amount of nitrogen, pho phorus and potassium. Soluble fertiliz



Conventional Closed System



Water Isle Open System

can be purchased in any garden supply store; the label will read 6-6-6, 10-10-10, or 20-20-20, for example. These figures indicate the amount of salts of the three elements mentioned above in the fertilizer, in the order listed. Dissolve the fertilizer in the water at the strength indicated on the label, usually about one teaspoonfull to one gallon of water.

6. How is the nutrient solution applied to the plants? The solution is poured over the plants about once a week. This may be done with a pitcher, a sprinkler can, or an applicator attached to the end of a hose. This last method is most convenient as you put the required amount of fertilizer in the bottle and water pressure mixes and applies the diluted solution. Make up only enough of the solution to wet down the crushed stone in the bed. Naturally the amount needed will depend on the size of your garden.

7. What else should you do? The plants ought to be watered every day when it doesn't rain. A little dry fertilizer may be sprinkled over the surface of the bed occasionally is desired. About once a month it sometimes is desirable to substitute a high phosphate fertilizer for the weekly feeding of balanced fertilizer—this stimulates fruiting. The label of this fertilizer will show the middle number high—such as 10-39-10. There is a lot of talk about the trace elements. These are essential to plant growth but are required in such minute quantities that most fertilizers contain enough impurities to provide sufficient amounts. But if you like you can substitute an orchid fertilizer for the regular sort—this contains the trace elements but it is more expensive.

8. What are the greatest advantages of growing hydroponically? It takes much less water to grow plants hydroponically than in the ground. In the States it is figured that it only takes one-thirtieth of

the amount of water to grow by this method. In the Virgin Islands where temperatures are higher and evaporation is greater, the savings may not be as great. Since water is so scarce, this is a big plus. Another advantage is that water and fertilizer are applied directly to the roots of the plant where they will do the most good.

9. What is the one best crop to grow? We have found tomatoes to be the most desirable vegetable to grow. We also have found that the medium-sized cherry and plum tomatoes (both red and yellow) produce a greater volume of fruit than the large-sized tomatoes. We not only have enough for our table but surplus to give to our friends or to sell. A new crop should be started every three months or so to have a steady supply.

10. How does the quality of hydroponically produced vegetables compare with that of those grown in the soil? They are equally nutritious and the flavor and appearance are better due to the fact that they have been produced under controlled conditions.

11. What about sun and wind? The site selected for the hydroponic garden should get full sun, or at least sun during several hours each day. It should be protected from strong winds; if necessary erect a windbreak.

12. What about insects and diseases? These usually are not a problem in the Virgin Islands. Sometimes leaf miners appear and these can be recognized by tiny wavy white lines in the leaves. An occasional spraying with malathion will control these as well as most other insects, including scale and mealy bugs. On rare occasions fungus may appear. Apply Physan or other fungicide.

13. What about flowers? Try growing a few of your favorite flowers, particularly for cut flowers. In fact, try any annual plants. You will be surprised at how well they will do.

•

The Bee Tree

Warren Balgooyen

When age to outer branches came
our waning tree did harbor
New life within its failing frame
a hollow hallowed arbor.

Its heart a rising reservoir
here nurtured life anew
As bees from a citadel afar
to this found fortress flew

Winged couriers to the fields
our tree again did send
Still sowing life, still gathering yields
achieving then sweet dividends

Thus filled with nature's sweetest store
our fallen tree did lend
Its riches to another shore
Farewell old fallen friend.

Pamela Bruns

Flowering branches of *Halesia carolina* in the Arnold Arboretum. Recent evidence has shown that this tree, formerly recognized as a distinct species, *Halesia monticola,* is best considered within *Halesia carolina.* A common name is snowbell tree.

CHANGES OF BOTANICAL NAMES

Stephen A. Spongberg

ONE of the most frustrating facts that botanists and horticulturists, nurserymen and gardeners alike must face is the occasional change of the botanical names of some of the plants they know and grow. Most botanical name changes are at the species level or below, and these changes frequently creep into the gardening literature without amplification.

When the name change involves a widely known cultivated ornamental or an economically important plant, the resulting confusion is often considerable, and one's frustration is increased, especially if the reasons and rationale for the change are not explained or understood. It is only natural that a change be questioned, especially if the old, replaced name is well established in the trade and in botanical and horticultural literature. It is also natural to question why such a change is necessary, advantageous, and/or allowed. Without understanding the basic reasons behind a change, one is tempted to remain in a state of inertia and resist using the new name.

Botanists and horticulturists give names to taxonomic groups so they can easily and universally refer to them in identical terms, and at the same time indicate their taxonomic rank. And although the reasons behind a change of botanical name are often complicated and may differ from one case to another, any change, in the last analysis, is the result of one of two basic considerations, or in most instances, a combination of the two.

First, a name change may occur as a result of taxonomic research on the relationships of the plants themselves. The evidence for a needed change of status, and therefore new name, of a particular plant or group of plants is usually derived from a study of morphological, anatomical, genetic, chemical, geographical and other biological characters and attributes of the plants themselves. In the second instance, the name change is required for strictly *nomenclatural* reasons that have no relation, per se, to the taxonomy of the plant or plants concerned. Evidence supporting nomenclatural changes is derived from studies of botanical and horticultural literature that seek to ascertain the first description and to determine the correct name of the group of plants being studied. In other words, either the name change reflects a new or re-established taxonomic interpretation or order, or it is required for strictly nomenclatural reasons.

These are extremely important distinctions, because taxonomy and nomenclature are often confused with one another, even by botanists. In any event, by international agreement, botanists follow and adhere to the rules of nomenclature embodied in the *International Code of Botanical Nomenclature* in the application of names to plants. Even when a study is purely taxonomic, it still requires a re-evaluation of the plant names in relation to the code of nomenclature. Thus, many name changes are due to a combination of nomenclatural and taxonomic factors.

But the taxonomic and nomenclatural reasons for alterations of botanical names and the relationship of taxonomy and nomenclature are best illustrated by examples, and the ones I have chosen involve the names of cultivated trees and shrubs. Certainly not all of the rules of nomenclature can be illustrated here, but a few of the more common situations that require name changes are discussed below.

One of the most straight-forward causes for a change in name is the discovery of an earlier name for the same group. The earlier or older name, under the rule of priority, is the correct name. The sweet or yellow buckeye has for many years been known as *Aesculus octandra,* a name that was published by American plant collector Humphrey Marshall in 1785. However, the correct name for this species is *A. flava* because it was published in 1778 (seven years prior to Marshall's publication) by the British botanist Daniel Solander. This is a clear-cut case of priority, and the name change results for strictly nomenclatural reasons.

Changes Among Magnolia

Another example that necessitates a name change for nomenclatural reasons relates to the rule stating that within a given genus a particular specific epithet or name can be used only once. In other words, the same name cannot be given to two different species within the same genus. For example, the name *Magnolia parviflora* was given to a plant by Karl Ludvig Blume in 1825. In 1845, Siebold and Zuccarini also described a species of *Magnolia* and gave it the same specific epithet, with the result that two different species had been given the name *M. parviflora.* In nomenclatural terms, the name *parviflora* was "occupied" within the genus *Magnolia* and could not be used a second time. As a result, the new name, *M. sieboldii,* was proposed by Koch in 1853 to replace the second *M. parviflora,* and it has been only in recent years that the correct name has completely replaced the widespread use of the incorrect one.

A further example from the genus *Magnolia* involves both taxonomic and nomenclatural considerations. Today, on the basis of taxonomic evidence, *Magnolia cordata* is considered to be a variety of the cucumber-tree, *M. acuminata.* When this proposal of the taxonomic status was recently re-suggested in 1954, *M. cordata* was given the name *M. acuminata* var. *cordata.* In other words, the change in taxonomic rank was reflected in the combination of var. *cordata* with *M. acuminata.* But in 1839 these plants had already been treated as a variety, and the name *subcordata* was used. Thus, the newly proposed combination was incorrect since according to the rules a name can be considered for priority only in the rank to which it was originally assigned. The name *M. cor* *data*, as a species, was proposed in 1803 and later as a varietal epithet in 1849. As a varietal name, *subcordata* is ten years older than *cordata*. As a result, when these plants are treated as a variety the correct name is *subcordata*, while the name *cordata* is correct only if the plants are considered as a distinct species. It should be noted, however, that not every change in taxonomic rank requires a corresponding change in name.

Snowbell or Snowdrop Tree

Recent taxonomic studies of the genus *Halesia*, the snowbell or snowdrop tree, indicate that the plants long known as *H. monticola* are not specifically distinct from *H. carolina*. The fact that *H. monticola* and *H. carolina* represent the same species became evident from taxonomic studies of morphological variation, geography, anatomy and cytology. However, since a particular species can have only one name, the choice had to be made between *H. monticola*, which dates from 1921, and *H. carolina*, which was proposed by Linnaeus in 1759, and here the problem became one of nomenclature. Again, through the application of the rule of priority, *H. carolina*, the older name, must be used when these two species are taxonomically united as one.

Conversely, studies of the cultivated species of *Stewartia* have shown that two distinct species have in the past been grouped within *S. sinensis*. The first species corresponds to the concept of *S. sinensis* as outlined by Alfred Rehder and Ernest Wilson who named that species, and this fact was confirmed by an examination of the type specimen. The second species, however, is distinct from *S. sinensis* and other recognized species of *Stewartia*, and as a consequence some of the plants in gardens and arboreta that have been known as *S. sinensis* are now known by the new name, *S. rostrata*. In this instance, the discovery of two separate species within the group of plants known as *S. sinensis* was the result of taxonomic studies. By contrast, the examination of the type specimen of *S. sinensis* to ascertain which of the two species retains that name, and which receives a new name, is a matter of nomenclature.

Flower and foliage of *Magnolia sieboldii*, long referred to as *M. parviflora*. (Photo taken by Alfred Rehder in 1903.)

The above examples illustrate only a few of the many reasons behind the changes of botanical names. As long as the provisions of the *International Code of Botanical Nomenclature* have been followed, changes for nomenclatural causes are apt to be less open to question and will result in greater stability of plant names so long as the taxonomy is accepted. Name changes that result from new taxonomic interpretations, on the other hand, may still require future revision as our knowledge of the relationships and biology of plants becomes more complete. This progress may not result in the comfortable stability of plant names many botanists and gardeners would desire. But these frustrating changes in plant names do reflect our advancing and more perfect understanding of the plant world. ☙

Photos by George Taloumi

The post-and-rail fence is a landscape feature, but this one also supports roses.

EARLY AMERICAN FENCES

Warren Balgooyen

THE TEATOWN LAKE RESERVATION, a Brooklyn Botanic Garden outreach station 45 miles north of New York City in Ossining, has a unique new exhibit that demonstrates a skill well known to our forebears—the art of rail-splitting. Since last August we have been preparing our own posts and rails for this display of early American fences.

In an effort to be as authentic as possible, the Reservation is presently engaged in what may be the last harvest of American chestnut *(Castanea dentata)* in our area. The fungus blight *(Endothia parasitica)* has made this magnificent species almost extinct in the wild as a tree, although shrub-like sprouts from old specimens are not uncommon to this day. The chestnut was especially noted for its timber; in fact, many authorities considered it the most valuable fores tree of the eastern United States. Th wood was employed for fence posts among other things.

Chestnut timber, even from long-dea trees lying fallow in the woods, is amaz ingly resistant to decay. A few old log that are still sound remain proppe against rock ledges or neighboring oak on hillsides and in ravines here at Tea town. What more appropriate use is ther than to put them to work in thi memorial to a vanishing skill?

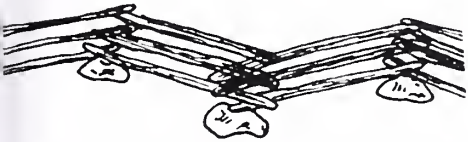
Fences add much to the beauty of landscape and are employed today a much for their aesthetic value as for utili tarian purpose. Working farms in ou time cannot afford wood or stone fence unless they are already there. Barbe wire or woven wire has replaced ther

These fences, of course, are strictly utilitarian, while split rails and the like are now relegated to suburbia. In Vermont they say that city folks build fences to keep things out while country fences keep things in. Most suburbanites, however, build fences to enjoy their beauty and to add charm to the landscape.

Here are the fences of yesteryear that have been recreated at Teatown. We have used various kinds of wood, and our discovery of the old chestnut logs will enable us to refine and expand the display as time goes by.

SNAKE OR ZIG-ZAG FENCE

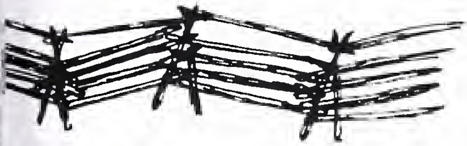
First in common use—Circa 1700



This type of fence was often used where the land was too rocky to get a post hole in. (Note how the entire fence rests on rock cushions.) It is one of the earliest of fence designs and was much in use by the settlers. It is one of the longest lasting fence types because the wood has no contact with the soil. However, because of its zig-zag form this fence is wasteful of wood and land. One cannot plow or mow close to the fence. For these reasons it was no longer in popular use after 1800 in most areas.

SNAKE AND CROSS FENCE

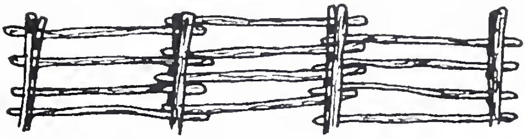
First in common use—Circa 1700



This fence is a variation of the zig-zag type which provides additional bracing at the corners to prevent cattle from pushing off the top rail.

DOUBLE POST-AND-RAIL

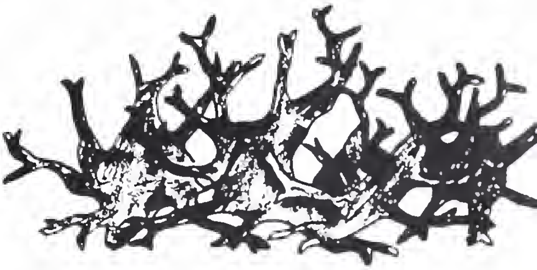
First in common use—Circa 1700



This type of post-and-rail was much more common on farms during the 1800's than the type of post-and-rail we see today in suburban yards. Farmers could not spare the time required to "hole out" posts. One hole was dug and the two posts installed. Spacers for the rails were variable. Many farms used an iron rod to support the rail. Where nails were available, a wood spacer was cross nailed as exhibited.

SETTLERS STUMP FENCE

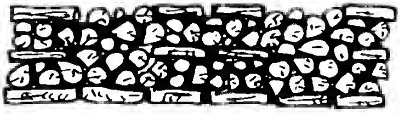
First in common use—Circa 1650



When the land was first cleared in New England, there were a lot of stumps to dispose of. With typical Yankee inventiveness, these were dragged to the edge of a cleared area, using oxen, and set up as fences. "Stumping out" was accomplished by digging around a stump until a large side root was encountered. A chain was fastened to this root and across the top of the stump to the yoke of oxen. When the oxen pulled, the stump would turn over and come out. This type of fence is very long lasting. A few stump fences can still be found in New England and—in use!

CORDWOOD FENCE

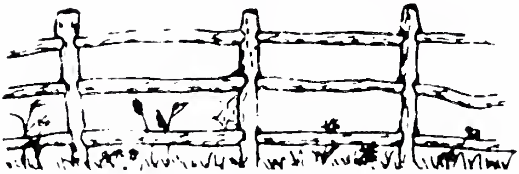
First in common use—Circa 1750



Some early farms used the cordwood fence. While appearing to be wasteful of wood it was, in fact, a practical way of storing wood. This section was built from one tree about 1 foot in diameter. The wood was later used for fuel after seasoning, section by section. When a section was used for fuel it was replaced with stone. In this way a field could be quickly enclosed to confine livestock, putting the farmer's woodpile to double purpose and giving the farmer the time to build his stone fence. This type of fence is still in use in Scandinavia.

POST-AND-RAIL

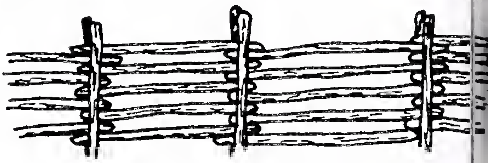
First in common use—Circa 1800



Post-and-rail fences of this design, while common today, were reserved for special uses in former years because of the extra labor involved in their construction. Where a fancier type of fence was desired along a road or around the farm house, a fence like this was built. Holes were cut in the posts with a special post axe and a hand auger. Most of these fences were built of chestnut because the wood was durable outdoors and split easily for rails. Today's suburban fences are generally of locust (for posts) and sassafras, oak, maple or other hardwoods for the rails. These rails are not nearly as long lasting as the chestnut rail, but the locust posts are just as good. Our fence is built entirely of Teatown-grown locust and should last several decades.

SOLID STAKE FENCE AND SETTLERS GATE

First in common use—Circa 1700



This type of rail fence is similar to the double post-and-rail but does not have spacers between the rails. Instead, the rails rest directly on each other. On most farms it predates the double post-and-rail because it did not require any nails or hardware.

The Settlers Gate was an ingenious idea that permitted people to get through the fence without the cattle getting out. Walk through the one at Teatown and you will see how the sharp turn kept the cattle in.

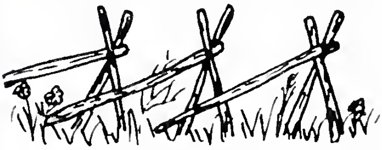
STONE FENCE OR DRY WALL

First in common use—Circa 1700

Stone fences are, of course, the ultimate in durability. The eastern United States is well endowed with a heritage of stone walls, many of which were built before the Revolution. Some of the walls in our area were made by prisoners during the Civil War. Larger stones were moved with oxen and rolled in place with levers. Our wall, 8 feet long and 3 feet tall, was constructed by two members of the Teatown staff in six hours. An experienced stone worker could probably do 20 feet or more a day (depending upon the availability of stone).

STAKE-AND-RIDER

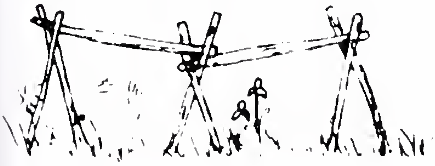
First in common use—Circa 1750



The stake-and-rider fence is a bristly looking barricade that was much in use in Vermont and other sections of New England by the early settlers. The type of fence is very solid and was effective in confining oxen, steers, work horses and other large animals.

ONE-POLE FENCE

First in common use—Circa 1700



This type of fence took less wood than the stake-and-rider, but was not as strong. It was easy to build and quite common in many parts of the country.

Stone fence with wooden gate.

A Word About Wire Fences

When wire became easily available, wood fences were no longer dominant in the rural landscape. The invention of barbed wire was a boon to American farmers. Many types were devised and a lot of people today collect the various kinds—some of which are very rare and represent distinct time periods. Teatown has an old fence of ribbon wire along the bee tree trail. It predates barbed wire and has not been in use for many decades. It would be too expensive to manufacture today. With the spiraling cost of contemporary wire fencing, rural folks may soon be back to splitting rails! ☙

FOR FENCE STRADDLERS

IF YOU VISIT Teatown Lake Reservation in Ossining, N. Y. to see the display of early American fences, allow time to wander along the trails in this 306-acre preserve. There is also a nature museum with seasonal exhibits. Teatown is about an hour's drive north of New York City. Best route from northern or southern points: Take the Taconic State Parkway to Route 134, then go west on Route 134 one-quarter mile and follow the directional marker to the Reservation. Hours: 9 AM-5 PM, Tuesday-Saturday; 1 PM-5 PM Sunday; closed Monday. (Telephone: 914-762-2912).

The Kitchawan Research Station (223 acres) of the Brooklyn Botanic Garden is a two-mile drive east of Teatown on Route 134. When visiting, make sure to see the series of small home demonstration gardens (herbs, roses, fruits, vegetables, etc.). There are also nature trails at Kitchawan. The grounds are open during daylight hours. (Telephone: 914-941-8886.)

THE CONTROLLING OF FUNGAL DISEASES WITH SYSTEMICS

R. L. Wain

From the JOURNAL OF THE ROYAL HORTICULTURAL SOCIETY, May 1974

LIKE man and animals, plants suffer from infectious diseases which can weaken and destroy them. While bacteria and viruses are responsible for most of the infectious diseases of man it is the pathogenic fungi which are the main agents of plant disease. These are the pathogens which cause the blight, scab, wilt, rust and mildew diseases, and which throughout history have played such havoc with food crops.

Some of the calamities caused by plant disease are well known; the famines in Ireland, for example, in which during the "Hungry Forties" over a million people died of starvation, arose from the destruction of the potato crop by blight. Even today, total losses can occur; furthermore, attack by fungi is going on all the time, lowering the yields and the quality of our crops.

With the present-day shortage of food in a world whose population is steadily increasing, the control of plant diseases becomes a matter of vital importance. Proper cultural operations, the rotation of crops and the use of seed and planting material free of disease are all important methods of reducing crop losses due to fungi. Then it is often possible for the plant breeder to produce a new variety which possesses resistance towards a particular fungal pathogen, though such resistance may in practice be short-lived.

The most important method of controlling fungal diseases of plants, however, is by the application of chemicals either to the seed, the soil or to the plant. Spraying the foliage is the most common procedure, and by this means it is often possible to eradicate fungal infections such as the powdery mildews, most of which are restricted in their growth to the leaf surfaces. A majority of the fungi which attack plants, however, penetrate deeply into the leaf tissues so that once such a fungus has become established it is almost impossible to effect eradication by means of a foliage spray.

Against this type of attack, therefore, fungicides with a protective action are used; they must be applied to the leaves before the fungal spores germinate. While a protective fungicide must be toxic to the fungal spore it must not injure the host plant, that is, be phytotoxic. This "selective" toxicity between fungus and plant is not easy to achieve because the objective is to destroy a fungus, itself a form of plant life, which is attempting to live on or within the tissues of another plant. Nevertheless, there are available a number of excellent protective fungicides which, although not entirely free from phytotoxicity, are playing an important part in controlling plant diseases. Bordeaux mixture, made from copper sulphate and lime, is outstanding in this connection, and potato blight, apple scab, banana leaf spot, downy mildew of the hop and of the vine and many other diseases are effectively controlled by this material.

There are few more important materials than bordeaux mixture which, since its discovery by Millardet in 1885, has been used continuously for protecting crops against fungal diseases. With such a useful fungicide, it is very necessary to know as much as possible about its mode of action, and much research has been done along these lines. It is now known that the bordeaux deposit would be much less effective if it were not for the fact that the fungal spore itself exudes chemical substances which bring toxic quantities of copper from the deposit into solution. The chemicals which are present in the material exuded from the spore have also received a good

Bordeaux mixture, a combination of lime and copper sulphate, was first used in France on grapes to discourage pilfering. Then it was discovered that leaves coated with the mixture were resistant to the mildew that had been ravaging the vines.

George Taloumis

deal of study and, as a result, much is now known about the mode of action of bordeaux mixture. Such research is not only of value from the fundamental viewpoint but it helps us to understand what factors are important to the field performance of copper fungicides.

Fungicidal activity is known to depend upon a number of factors and among these, physical properties are important. Thus the toxic chemical must be capable of penetrating into the fungus and be able to reach the site of action at cell level. At this site of action the chemical must then exert its toxic effect either by a physical mechanism such as by accumulating at a cellular boundary and so altering its properties, or by interfering chemically with at least one of the vital chemical processes operating within the living cell. Since these same principles must apply in the destruction of any living organism, it is clear that "selective" toxicity will be more readily achieved if there are outstanding differences between the host and the parasite in relation to their metabolism, cellular make-up and the like. Between insects and plants there is a wide range of metabolic differences to be exploited; for example, insects possess a nervous system whereas plants do not, and their nutritional requirements are also very different. It is not surprising, therefore, that a number of non-phytotoxic insecticides have been discovered.

In seeking a fungicide for application to plants, however, there are much narrower differences, for here we are trying to destroy the fungus—which is itself a form of plant—living on or within the tissues of another plant. Even so, the biochemistry of the fungus and the host plant are dissimilar in some respects and selective toxicity between fungus and plant is therefore not impossible, although the margin for selective action is usually a narrow one. Another factor to be considered in research on fungicides is that a crop growing in the field may be exposed to infection for long periods, so that a prolonged protective action on the plant surface is usually necessary. This means that the stability and tenacity of the residual deposit after spraying are always important factors in determining the field performance of a chemical.

In recent years a large number of organic compounds have been examined as fungicides. Research has shown that there are certain chemical groupings which appear to confer fungicidal properties to a molecule so that the search for new and improved materials is becoming less empirical.

Plant Chemotherapy

Protective fungicides provide no control of the vascular wilts and other soilborne fungal diseases. Furthermore, when such a fungicide is applied to a plant, only those parts of the leaves and stem which are covered by the deposit are protected against invading fungi; indeed, any parts which have been inadequately sprayed or from which the chemical has been removed by weathering are liable to attack, and so is all new growth. Such disadvantages are overcome by using a chemical which can act systemically—that is, one which can move in the plant and exert its action from within the tissues.

Actually, this idea of plant chemotherapy is by no means new; in Müller's *Die innere Therapie der Pflanzen*, for example, written some 40 years ago, a number of experiments of this type were described. Most of this early work, however, was of an empirical nature, and although claims were made from time to time that particular treatments were effective, no reliable methods ever became established for controlling a plant disease by internal therapy. On the other hand, as is well known, spectacular successes have been achieved by chemotherapy in the control of certain human and animal diseases using such materials as sulphonamides and antibiotics. The plant, however, differs markedly from the animal in that it lacks a central circulatory system with blood and lymph to transport the defensive materials. The distribution of any applied chemical throughout the tissues of a plant following application to roots, leaves or stem is a slower process depending largely upon diffusion from cell to cell. In spite of this limitation, the control of certain plant diseases with chemicals acting systemically has been successfully accomplished and a number of materials are now used commercially for this purpose.

Systemic Fungicides

In the Agricultural Research Council's Unit, at Wye College in England, we have been concerned with research on systemic fungicides for a number of years. In our earlier work we concentrated our attention on compounds which had no detrimental effects on the host plant yet which were freely moved in the tissues. The results of this research, together with those of other workers, indicated three possibilities whereby systemic fungicidal activity might arise. Firstly, the chemical itself might be fungicidal and operate as a systemic fungicide; secondly, the chemical applied might be non-fungicidal but changed to a fungicidal compound in the plant and thirdly, the chemical applied might affect the plant's normal metabolism which in turn could lead to a change in disease resistance.

Because of the dramatic results obtained in the control of certain animal diseases with antibiotics it was logical to examine such compounds as systemic fungicides in plants. One of them, griseofulvin, was found to be effective against such diseases as powdery mildew of roses, tulip fire and grey mold of lettuce. Furthermore, a range of compounds chemically related to griseofulvin were found to be effective, some being more active than griseofulvin itself. None of these is used commercially, however, as other well-established fungicides can be used more economically.

Encouraging results and exciting possibilities arising from systemic fungicidal research led some of the industrial firms to develop screening programs in which many thousands of chemicals could be examined routinely. As a result, a number of highly effective systemic fungicides have been discovered. A detailed account of the properties and performance of these synthetic chemicals is given in *Systemic Fungicides*, edited by R. W. Marsh (London: Longman, 1972). A pyrimidine derivative, dimetirimol, discovered at Jealott's Hill Research Station, was one of the first effective synthetic compounds. It was found to give a spectacular control of powdery mildew on the leaves and stems of cucumber, a single application to the soil providing control for about six weeks. A related compound, ethirimol, gave good control of powdery mildew of barley when applied as a seed dressing. Two other compounds, carboxin and oxycarboxin, were discovered by the Uniroyal Company in Canada. Carboxin is effective as a seed dressing against loose smut of barley and wheat, neither of which is controlled by organomercurial dressings, and oxycarboxin shows promise against wheat rust. Benomyl ("Benlate") from the Du Pont organization in the U.S.A. is highly active against various powdery mildews. However, it is a good fungicide as well as a systemic fungicide and it has been found to perform well against many other fungal diseases of vegetables, flowers and fruit.*

Among other synthetic systemic fungicides, triforine and tridermorph are worthy of mention; both are effective against powdery mildews as is the formamide systemic fungicide discovered at Wye College.

At the present time the main uses of systemic fungicides seem to be the control of powdery mildews, loose smuts and certain rust diseases. They are able to provide protection, to eradicate established infections and, in some cases, can control deep-seated pathogens which have previously not been accessible to chemicals. Most of the evidence, however, indicates that whereas the compounds move upwards in the transpiration stream, downward movement does not readily occur. Their use on trees and other woody plants, in our experience, has been disappointing. With their extensive root systems these are not only more difficult to treat through the soil but translocation does not seem to occur so readily with woody as with annual plants.

There is no doubt that the discovery of systemic fungicides which can move down to the roots following application to the leaves and be released into the soil in the root zone would be of great importance. It could not only provide a sound approach to the control of root diseases but the same concept could well be applied to nematode control as well. With such objectives in mind, chemicals similar to x-methoxyphenylacetic acid, which is known to move down to and be exported from plant roots following application to the leaves, are being examined in the laboratory at Wye.

There is now considerable evidence that fungi which were originally susceptible to commercial systemic fungicides are developing resistance towards them. Such resistance can arise from genetic changes in the fungal cell which originate as mutations. It could be explained by the fungus developing an ability to break down the fungicide or it could arise from effects on fungal cell membranes operating to prevent entry of the systemic chemical. At any rate, building up of resistance is now creating serious problems; indeed in some cases as, for example, when the chemical is used repeatedly in a confined area such as a glasshouse, control may become negligible. Such a situation has in fact already arisen in cucumber mildew control with a number of the commercial compounds which originally were highly effective.

Another approach to plant disease control which is being followed in the A.R.C. Unit at Wye College will now be briefly discussed.

Natural Resistance

In nature most plants are not susceptible to most of the fungal pathogens to which they are continuously exposed during their growth. Roses, for example, though susceptible to black spot, are immune from potato blight, cereal rust, apple scab and so on. Thus, resistance is the rule rather than the exception in nature. Although such resistance can sometimes be related to morphological characteristics, such as a waxy leaf epidermis or other factors, there is evidence that natural resistance to infection may be associated with the presence of protective chemicals within the plant cells. Numerous antifungal compounds have in fact been isolated from plants. A compound of very high activity is wyerone, isolated in my laboratory at Wye from seedlings of broad bean. The chemical has also been synthesized. Although highly fungicidal towards a range of fungal pathogens, wyerone was found to have little activity towards the pathogen which causes chocolate spot disease of broad bean.

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* *Editor's Note*: A number of these systemic fungicides, excepting the well-known benomyl, have not yet been released in the United States nor approved for use by the Federal government.

Such developments provide further indication that a plant's resistance to disease may be due at least in part to the presence of naturally occurring defensive chemicals within its tissues. These considerations then, provide another approach to plant chemotherapy and the discovery of "natural" systemic fungicides.

Another area of research is that of ph toalexins. These are antifungal chemica which are produced in plants in respon to chemical or physical injury and whe the plant is subjected to fungal infectio A large number of phytoalexins are no known. Their chemical structures hav been established and their fungicidal pro erties have been assessed; examples a pisatin from peas and phaseolin and kiev tone from beans. A recent development i this area of research is the finding in th A.R.C. Unit at Wye that infection c beans with the tobacco necrosis virus lea to the production of a group of phyt alexins which thereby confer a degree c fungicidal protection on the plant.

From the foregoing, it can be seen tha research on the control of plant disease is proceeding along many fronts. We hav seen that while it is common for a plan to show a sustained resistance towards a tack by a fungus, the control provided b synthetic systemic fungicides is alread breaking down. It may well be that re search on chemicals involved in natura disease resistance will help to stimulat the design and discovery of new materia for use in this importat area of crop pro tection.

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SEED DIVIDEND FOR MEMBERS

Depending on the coming summer crop there will be available to Botanic Garden members a limited quantity of seeds of shooting-star (*Dodecatheon meadia*). It is essentially a midwestern wildflower, though the native range extends east to Pennsylvania and south to Georgia and Texas. The small, deep rose flowers, which are borne on stalks 6 to 20 inches tall, appear from April to June according to locality. For best performance, shooting-star requires a light woodsy soil and partial shade. If interested in participating in this seed dividend, send a stamped, self-addressed envelope to the Editor, Brooklyn Botanic Garden, 1000 Washington Ave., Brooklyn, N. Y. 11225. For information on membership write to Mrs. Norman Free in care of the above address. Expect seeds to be sent in the latter part of summer.

The shooting-star seeds are made available through the generosity of Mr. and Mrs. Harold Clegg, members who live in Lafayette, Indiana. The Cleggs, who are keen horticulturists, oversee the Jerry E. Clegg Botanical Garden, which is open to visitors. For information about their woodland arboretum, see BBG Handbook No. 64, *American Gardens—A Traveler's Guide* (Autumn, 1970 PLANTS & GARDENS).

THE TRAIL OF MOSSES AND LICHENS

Kenneth A. Wilson

From Flower and Garden, November 1974

The trail I was following ended on the summit of an Adirondack mountain; a windswept place of exposed granite, of long winters and bitter cold, of stunted balsams and spruce. Yet there at my feet spread some of the loveliest "gardens" imaginable. Dark moss grew on patches of thin soil accumulated through centuries where struggling low bush blueberry now clung to rock, and over this green carpet a cream of white frosting of "reindeer moss" lichen had grown luxuriantly.

The most beautiful flowers in our gardens may be descendants of these lowly, primitive plants of harsh places. Some hink the land life on the planet, as we know it, may be wholly dependent in ichens for its beginnings. They are the irst living things to colonize bare rock, and once established slowly etch away the surface with acids; making the basis of soil. In this meager soil the mosses get a root hold. Beds of moss build soil more rapidly from products of their own decay and by trapping air-borne debris, so seeds of trees can germinate.

A lichen's tissues are in fact made up of two distinctly different kinds of plant ife. Some time in a distant past cells of algae and fungi learned how to live together, each supplying the other's specific need, in perfect cooperation. Of the two, only the alga with its chlorophyll can turn water and air, with traces of mineral, into arbohydrates needed for growth by both plants. The fungus is fed by the alga in xchange for water the fungus stores in pongy tissue, and minerals its acids disolve from rock, bark or rotten wood. Inmate details of the whole process are till largely a mystery.

Winter months are often best for lichening. Or the cool, rainy, foggy days of late all and early spring. Then these beautiful ttle pioneers expand with moisture and ut on their most exquisite exhibitions of color against water-darkened surfaces of bark or stone. One of the secrets of survival lies in the fungus cell's ability to retain water in reserve for dry times. Hard winds, drouth, bitter cold; conditions that would spell instant doom to our tender plants are all to a lichen's liking.

Just "above" lichens in the scale of living things come the mosses. How drab might the world be without moss! Soft carpets in wooded glades, green and brown clothing for boulders, and filling damp bogs with foot-deep sphagnum where rare pitcher plants and orchids and sundews thrive. Be thankful for the moss that holds precious soil on washed slopes. Here is a plant whose usefulness at least equals its beauty.

Mosses and lichens belong to the class of non-flowering plants which reproduce by spores rather than seeds. In early spring, beds of common mosses will be seen glowing in sunlight as if possessed of a bay-colored fur. Translucent stalks, fine as hair, have arisen, each suspending a tiny green capsule filled with spores. After the container has ripened to brown, a lid called the operculum will detach, releasing a powdery mist of microscopic spores. Spore capsules may be found nearly year round for some species mature in fall and winter.

Common names are misleading in this realm of primitive plants. There are "mosses" that aren't moss. Reindeer moss is a lichen, as are also the long strands of beard moss (lichen) which trail from spruce branches along damp northern coastlines and may beard faces of sheer rock as well. Reindeer moss lichens will dry to the brittleness of chalky old bones, only to be resurrected into cream and pale green life under the first rain. Specimens, on being soaked, have returned to the living after nearly a hundred years of dry dormancy, so persistent is the life force and so important are these rugged pioneers in the scheme of natural things.

SOURCES FOR BOOKS BY MAIL

Pamela J. Harper

HUNDREDS OF GARDENING BOOKS are published each year. Some are of fleeting interest but the information contained in others makes them valuable sources of reference for many years. Few stay long on the shelves of the average bookstore, which usually contain a mere dozen-or-so of the latest publications. So, the gardener wanting access to the full range, or seeking rare or out-of-print books must turn to the firms who specialize in garden books. Most issue catalogs and in some cases a modest charge is made for this. The following list should be helpful to readers. If you know of additional mail-order firms listing a wide variety of such books, please write the Editor.

Abbey Garden Press, 1593 Las Canoas Road, Santa Barbara, California 93105. Mainly cacti and succulents. Catalog 25 cents.

American Nurseryman Publishing Co., 343 South Dearborn Street, Chicago, Illinois 60604. Periodic list of books especially useful to those who work with plants every day.

G. A. Bibby, 714 Pleasant Street, Roseville, California 95678. Used.

Bookquick, B-7, Roseland, New Jersey 07068. No catalog. Will quote for most in-print garden books.

H. Lawrence Ferguson, Box 5129, Ocean Park Station, Santa Monica, California 90405. New and used.

Garden Way Publishing, Charlotte, Vermont 05445.

Marian L. Gore, Box 433, San Gabriel, California 91775. Mostly used, some new.

HHH Horticultural, 68 Brooktree Road, Hightstown, New Jersey 08520. New.

Hilltop House, 1 The Loch, Roslyn, New York 11576. Rare and out of print.

John Johnson, RFD 2, North Bennington, Vermont 05257. Out of print.

Augustus M. Kelley, Box 458, Little Compton, Rhode Island 02837. Antiquarian and a few new.

Mellinger's Inc., 2310 West South Ran
Road, North Lima, Ohio 44452. Exte
sive list in a general nursery catalog.

Pomona Book Exchange, 33 Beaucou
Road, Toronto 18, Canada. New, use
rare.

Santa Paula Books, Box 384, Santa Paul
California 93060. Old and rare (esp
cially roses).

Richards Flowerbooks, Box 507, Fo
Collins, Colorado 80522. New ar
used. Catalog $1.00.

S. J. Singer Co., 1133 Broadway, Ne
York, N. Y. 10010. New, out of prir
rare. Request Catalog #105 $1.00.

Laurie Todd's, 8 East Baltimore Avenu
Lansdown, Pennsylvania 19050. Ne
and out of print.

Elisabeth Woodburn, Booknoll Farr
Hopewell, New Jersey 08525. New ar
out of print.

William P. Wreden, Box 56, 200 Ham
ton Avenue, Palo Alto, Californ
94302. Stipulate horticultural catalo

Two large firms dealing in remainder
books, some of them horticultural, a
Marboro Books Inc. (205 Moonac
Road, Moonachie, New Jersey 0707
and Publishers Central Bureau (1 Cha
pion Avenue, Avenel, New Jersey 0713
Both issue catalogs. The American G
den Guild, Garden City, New York 115
operates on a book club basis, offeri
mostly new books, usually at a discou

Some of the specialized plant societ
have books available for their membe
frequently at reduced prices. For a list
societies and their addresses, see *Directo*
of American Horticulture 1974, publish
by the American Horticultural Socie
Mount Vernon, Virginia 22121.

Occasionally, regional organizatio
have book-loan services for their me
bers. Two of them with very extensive
braries are the Massachusetts Hortic
tural Society (300 Massachusetts Aven
Boston, Massachusetts 02115) and
Pennsylvania Horticultural Society (3

Walnut Street, Philadelphia, Pennsylvania 19106).

Some garden books by English authors are published jointly in England and the United States. Others are not and must be obtained from England. Many old and rare books are also more likely to be found in England. The cost of mailing at book rate is very low but expect to wait six weeks for delivery. The following are well-known firms.

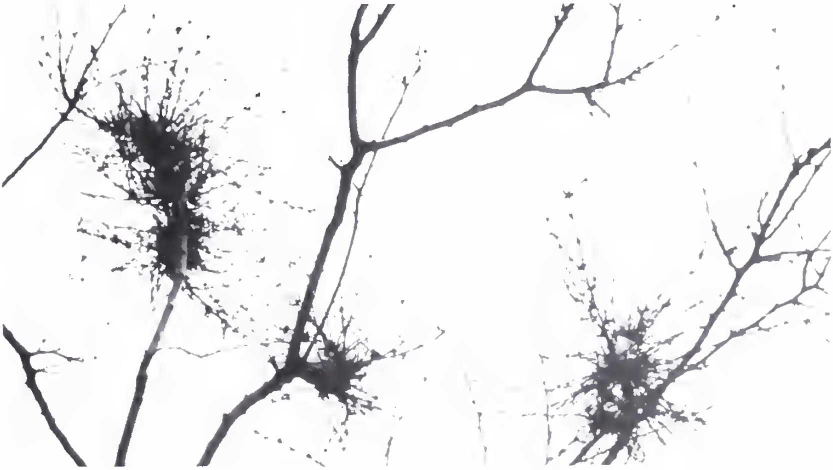
Daniel Lloyd, 4 Hillcrest Avenue, Chertsey, Surrey, England. Catalog $1.00. Out of print, old and new. Searches for rare books.

Bernard Quaritch Ltd., 5-8 Lower John Street, Golden Square, London W1V, 6AB, England. Rare and antiquarian.

Landsmans Bookshop Ltd., Buckenhill, Bromyard, Herefordshire, England. Catalog $1.00. Any in-print English publication.

Wheldon & Wesley Ltd., Lytton Lodge, Codicote, Hitchin, Herefordshire, SG4, 8TE, England. Out of print, old and new. Catalog $1.00.

Many publishers issue periodic catalogs of their books, usually listed by subject. If cash is sent with order the book is usually mailed free of charge but some publishers make a mailing charge, so check on this. To obtain a *Directory of Publishers* send 25¢ plus a 20¢ stamped, self-addressed envelope (minimum size 8¼ x 4¼) to National Association of College Stores, Oberlin, Ohio 44074.



HACKBERRY IN THE WINTER

A FAMILIAR WINTER SCENE in many parts of the country is the tracery of hackberry against the sky. Very often the branches of the common northern species, *Celtis occidentalis,* are laden with witches'-brooms, which are congested growths of short dense twigs. Plant scientists are unsure of their exact origins, but a fungus and mite have commonly been associated with the brooms and, in recent years, a mycoplasm has also been discovered. The brooms are prolific on some hackberries, resulting in relatively low tree height (15-20 feet), while other specimens are unaffected or nearly so, growing to 60 feet or more. Regardless of the causes, broom-covered hackberries can lend character to a bleak January landscape, and discerning gardeners have learned to put them to work for seasonal interest.

RECENT BOOKS WORTH NOTING

In the Library of the Brooklyn Botanic Garden

(Please order directly from your bookstore, not from the Botanic Garden.)

BIOLOGICAL CONTROL

Biological Controls of Plant Pathogens by Kenneth F. Baker and R. James Cook. W. H. Freeman and Co., San Francisco. $12.50.

An excellent, very detailed college-level text on what has been done and what might be done.

Biological Control by Natural Enemies by Paul Debach. Cambridge University Press, New York. Hard cover $14.95, soft cover $5.95.

Carefully considered, fascinating story of how insects and other small, living organisms have been put to work for man's purposes. One of the best accounts to date on this subject for the layman.

CURIOUS PLANTS

Bizarre Plants by William E. Emboden. Macmillan Publishing Co., New York. $10.95.

Lively, knowledgeable account of some natural wonders, including *Amorphophallus titanum,* our planet's tallest floral structure, and *Rafflesia arnoldii,* which has the largest single flower. Chapters on mandrake, ginseng and, of course, insectivorous plants. Pleasant bedtime reading for the non squeamish.

The World of Carnivorous Plants by James and Patricia Ann Pietropaolo. R. J. Stoneridge, Shortsville, N. Y. 14548. Soft cover $5.95.

A very sound, informative synopsis of this plant group and its care.

Carnivorous Plants by Randall Schwartz. Praeger Publishers, New York. $6.95.

A bit about butterworts and their brethren, with a few pointers on growing.

GARDENING

The Edible Ornamental Garden by John E. Bryan and Coralie Castle. 101 Productions, San Francisco (distributor: Charles Scribner's Sons, N. Y.). Har cover $7.95; soft cover $3.95.

Novel recipes for garden plants. Fuchsia cake, calendula egg spread, violet sala and others. Growing pointers, too.

Gardening with Water, Plantings, an Stone by Carroll Calkins. Walker an Co., New York. $7.95.

The importance of water as an architectural feature of the garden is given it due. Details on pool-making recirculatin pumps and sundry. Pondside plants.

10,000 Garden Questions, edited by Marjorie J. Dietz. American Garden Guil and Doubleday & Co., Garden City N.Y. $10.95.

Revision of an oft-consulted gardener' reference originally edited by F. F. Rockwell. Mrs. Dietz is also Associate Edito of *Plants & Gardens.*

The Terrace Gardener's Handbook b Linda Yang. Doubleday and Co., Garden City, New York. $8.95

Practical advice for growing plants o balcony, terrace and rooftops. Forewor by Elizabeth Scholtz of the Brooklyn Botanic Garden.

HERBS

Fun With Growing Herbs Indoors by Virginie F. and George A. Elbert. Crow Publishers, New York. Clothboun $7.50; soft cover $4.95

Herbs are interpreted more loosely b the authors than they are by most her growers, but some of these delightfu plants lend themselves adequately to indoor culture. Numerous photographs.

A Modern Herbal by Mrs. M. Grieve Hafner Press (Division of Macmilla Co.), New York. $25

Reprint of a 1931 classic. A massiv volume (916 pages), it contains herb lor —and fact—at its best.

The Concise Herbal Encyclopedia b

Donald Law. St. Martin's Press, New York. $7.95

An interesting British compendium of herb lore. The section on herbs and health may be appealing to some, but if one is ill, it would be more prudent to consult a physician than to engage in self-prescription.

HOUSE PLANTS

The Dictionary of House Plants by Roy Hay, F. R. McQuown and G. & K. Beckett. McGraw-Hill Book Co., New York. $17.95

A big, brassy volume from England with many color photographs, descriptions and cultural notes. George Kalmbacher of the Brooklyn Botanic Garden served as American consultant.

Living with Plants by William S. Hawkey. William Morrow & Co., New York. $15.95

A useful addition to the shelf for those interested in the relatively new field of indoor landscaping. Some common house plants and how to put them to work for best effect.

Philodendrons by Jack Kramer. Charles Scribner's Sons, New York. $5.95

Introduction to a popular group of house plants.

Books For Beginners

There has recently been a spate of house plant books marketed for the new gardener. Here are several inexpensive ones in paperback:

The Apartment Gardener by Florence and Stanley Dworkin. Signet Books (New American Library), New York. $1.50

More comprehensive than most.

How to Grow Beautiful House Plants by T. H. Everett. Fawcett Publications, Greenwich, Connecticut. $1.25

Revision of a 1953 book.

Greenworks by Judith Handelsman and Sara Baerwald. Collier Books (Macmillan), New York. $1.95

Somewhat higher priced:

Rx for Ailing House Plants by Charles M. Evans with Roberta Lee Pliner. Random House, New York. $3.95

MISCELLANEOUS

The Weather Almanac, edited by James A. Ruffner and Frank E. Bair. Gale Research Company, Detroit. $17.50

The weatherman seems to be doing less well now that he's computerized, and this book may help farmers and intrepid gardeners to understand the background. In any case, it contains a wealth of facts.

Nature's Colors by Ida Grae. Macmillan Publishing Co., New York. $14.95

Dye plant recipes.

A Traveler's Guide to North American Gardens by Harry Britton Logan. Charles Scribner's Sons, New York. $15.00

Essentially for the coffee table because of its numerous photographs, this book also provides some useful background information.

Food in History by Reay Tannahill. Stein and Day, Briarcliff Manor, New York. Soft cover $4.95.

Ever wonder what the Romans really did eat? Or have you heard of ergotism? It's caused by a virulent fungus (containing LSD among other things) that attacked rye in the Dark Ages and caused more deaths than most wars. This is a superb, detailed, world-wide treatment of the inter-action of man and food and the historical impact of some very common plants. Good bedside reading.

NATURE AND ENVIRONMENT

The Nature of Landscape Design by Nan Fairbrother. Alfred A. Knopf, New York. $10.00

Clear and refreshing thoughts on environmental planning by a sensitive, sensible English landscape designer. This posthumous book is perhaps even more pertinent to the American condition than to the English.

A Concrete Look at Nature by Eugene Kinkead. Quadrangel Press, New York. $7.95

An inquiring mind records random notes on the semi-natural life of Central Park and the environs of New York.

Wildflowers of Eastern America by John E. Klimas and James A. Cunningham.

Alfred A. Knopf, New York. $17.95

Excellent color photographs, good descriptions and an identification guide. A most useful aid for all who love flowers of the woods and fields. Also in the series is Robert T. and Margaret C. Orr's equally fine *Wildflowers of Western America* Same price.

Gardening with Wild Flowers by Frances Tenenbaum. Charles Scribner's Sons, New York. $7.95

A fresh treatment of the use of native plants in seashore, meadow and woodland gardens. Ferns and ground covers. Toxic and edible wild flowers.

PLANT GROUPS

Dwarf Bulbs by Brian Mathew. Arco Publishing Co., New York. $12.95

This extensive survey by a Kew (England) botanist should be a help to the avid collector of miniatures.

The Ivy Book by Suzanne Warner Pierot. Macmillan Publishing Co., New York. $4.95

Brief introduction by an enthusiastic amateur to a surprisingly ignored (in print) but most versatile group of indoor and outdoor plants. Perhaps this book will stimulate a detailed, authoritative treatment someday.

The Complete Book of Mushrooms by Augusto Rinaldi and Vasseli Tyndalo. Crown Publishers, New York. $14.95

A very attractively illustrated, relatively painless introduction, from Europe, to more than 1,000 of the world's mushrooms.

Cacti. A Golden Guide. By Frank D. Venning and illustrated by Manabu C. Saito. Golden Press, New York. $1.95

As always seems to be the case with this well-known series, a fine, clear, succinct introduction to the subject at hand.

TREES AND SHRUBS

Azaleas by Fred C. Galle. Southern Living/Oxmoor House, Birmingham, Alabama. Soft cover $1.95

A fine, basically regional sampling by one of the South's leading horticulturists. Ornamentally companionate plants also receive attention.

Flowering Shrubs and Small Trees by Jean Hersey. Charles Scribner's Sons New York. $7.95

Brief notes on 169 sorts with illustrations in color by Allianora Rosse.

Grow Your Own Dwarf Fruit Trees by Ken and Pat Kraft. Walker and Co. New York. $8.95

Culture, varieties and sources.

Trees for Your Garden by Roy Lancaster Scribner's, New York, $8.95

A very good, essentially pictorial depiction of selected trees, some of whic are available in North America, other not. The author, an English dendrologist is associated with the extensive nursery o Hillier and Sons.

Dwarf Shrubs by Donald Wyman. Macmillan Publishing Co., New York $7.95

This little volume by one of the dean of American horticulture covers bot evergreen and deciduous sorts. About 30 are described. Also, recently revised b the author, under the same publisher, i *The Saturday Morning Gardener* ($7.95) a low-maintenance guide for those wh can't pursue their gardening interest every day.

U.S.D.A. BOOKS

Seeds of Woody Plants in the Unite States. Agriculture Handbook No. 45 Published by Forest Service, U.S. Department of Agriculture. Availabl from Superintendent of Document U.S. Gov't. Printing Office, Washington. D.C. 20402. $13.60

Valuable reference for professiona who raise woody plants from seed.

Shopper's Guide. 1974 Yearbook of Agriculture. Available from Superintender of Documents, U.S. Gov't. Printin Office, Washington, D.C. 20402. $5.7

A 60-page section gives advice on th choice of plants.

WHAT'S IN A NAME?

A Dictionary of Useful and Everyda Plants and Their Common Names b F. N. Howes. Cambridge Universit Press, New York. $12.50

Bearing in mind that "common" nam

for plants are legion and would require a work the size of Bailey's *Standard Cyclopedia of Horticulture* to set straight botanically, this book may serve as a modest adjunct on the reference shelf.

Flowers and Plants by Robert Shostek Quadrange/New York Times Book Co., N.Y. $9.95

Origins of botanical names in dictionary format. Many interesting tidbits.

DOVER REPRINTS

Paperbacks available from Dover Publications, 180 Varick St., N.Y., N.Y. 10014

American Medicinal Plants by Charles F. Millspaugh. $10.00

All About Weeds by Edwin Rollin Spencer. $3.00

The Fragrant Garden by Louise Beebe Wilder. $3.50

•

North American Mushrooms
A Guide to Edible and Poisonous Mushrooms

Brenda Weisman

NEW MUSHROOM POSTER

EVER hear of the lurid boletus, livid entoloma or woolly lactarius? They are among the 35 North American mushrooms depicted on a new color poster sponsored by the Women's Auxiliary of the Brooklyn Botanic Garden. All have their own rich beauty, and skull-and-crossbone types are distinguished from safe ones. The poster was designed by staff artist Eva Melady, whose drawings are well known to many PLANTS & GARDENS readers. Printed on heavy white-coated stock, it is 25 inches wide and 38 inches tall. Eminently suitable for framing, the poster is available by mail for $3.75 from the Garden Shop, BBG, 1000 Washington Ave., Brooklyn, N. Y. 11225. (New York residents please add appropriate tax.)

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